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Implementation of cost as an independent variable : an AIM-9X case study

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THESIS

**IMPLEMENTATION OF
COST AS AN INDEPENDENT VARIABLE:
AN AIM-9X CASE STUDY**

by

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This research is a single case study of the implementation of Department of Defense (DoD) Cost as an Independent Variable (CAIV) into the AIM-9X Sidewinder air-to-air missile program to determine if CAIV has the attributes of a strategic management control system. Environmental forces—budgetary pressures, modernization requirements, and military performance requirements—have imposed upon DoD a need to change the way it conducts business, and implement an affordable, "best value" acquisition strategy through implementation of policies such as CAIV. However, there does not exist a managerial framework to assist the program manager in how to implement CAIV. There exist too many definitions of CAIV and priorities differ about what is the most important CAIV objective. This research uses DoD publications, memorandums, Internet websites, and published academic books and papers to review CAIV objectives, and the use of management control systems in commercial industry and DoD. After studying how the AIM-9X program implemented CAIV, this thesis analyzes and discusses CAIV in terms of a strategic management control system. When control is used in the sense of implementing strategy, CAIV has the attributes of a strategic management control system. CAIV has the capability to control individual behavior and incentives that lead to decisions affecting higher costs. Viewing CAIV in this managerial framework may assist DoD in implementing its affordability strategy.

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IMPLEMENTATION OF COST AS AN INDEPENDENT VARIABLE: AN AIM-9X CASE STUDY

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requirements for the degree of

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ABSTRACT

This research is a single case study of the implementation of Department of Defense (DoD) Cost as an Independent Variable (CAIV) into the AIM-9X Sidewinder air-to-air missile program to determine if CAIV has the attributes of a strategic management control system. Environmental forces—budgetary pressures, modernization requirements, and military performance requirements—have imposed upon DoD a need to change the way it conducts business, and implement an affordable, "best value" acquisition strategy through implementation of policies such as CAIV. However, there does not exist a managerial framework to assist the program manager in how to implement CAIV. There exist too many definitions of CAIV and priorities differ about what is the most important CAIV objective. This research uses DoD publications, memorandums, Internet websites, and published academic books and papers to review CAIV objectives, and the use of management control systems in commercial industry and DoD. After studying how the AIM-9X program implemented CAIV, this thesis analyzes and discusses CAIV in terms of a strategic management control system. When control is used in the sense of implementing strategy, CAIV has the attributes of a strategic management control system. CAIV has the capability to control individual behavior and incentives that lead to decisions affecting higher costs. Viewing CAIV in this managerial framework may assist DoD in implementing its affordability strategy.

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I. INTRODUCTION

A. PURPOSE

This research is a single case study of the implementation of Department of Defense (DoD) Cost as an Independent Variable (CAIV) into the AIM-9X Sidewinder air-to-air missile program at Commander, Naval Air Systems Command. The research objective is to analyze the implementation of CAIV in the AIM-9X program office and to determine if CAIV has the attributes of a strategic management control system.

Environmental forces—budgetary pressures, modernization requirements, and military performance requirements—have imposed upon DoD a need to change the way it conducts business. Acquisition reform represents a new directional strategy for DoD. CAIV is one of many acquisition reform initiatives designed to produce weapon systems "faster, cheaper, and better," and its effectiveness lies in its ability to change individual behaviors and incentives that lead to decisions affecting higher or lower cost.

However, from the research it is evident that many definitions of CAIV exist, the definitions are ambiguous, and different organizations in DoD have different priorities about what is important in implementing CAIV. This research illustrates that a conceptual approach, a managerial framework, or a theoretical construct of how to think about CAIV does not exist. It proposes that CAIV is really a strategic management control system, partly responsible for the implementation of acquisition reform strategy.

B. OVERVIEW

1. Cost as an Independent Variable

DoD introduced CAIV as a new initiative in its 04 December 1995 memorandum to the Service Acquisition Executives. (Kaminski, 1995) Attached to the memorandum is a DoD CAIV Working Group Report, which outlines the principle CAIV objectives program managers are to implement into program management. An earlier Office of the Secretary of Defense (OSD) policy memorandum in July 1995 committed DoD "to establishing a process whereby cost is an independent variable in programmatic decisions, and cost goals are set in each program phase." (Kaminski, 1995) Cost then becomes the "key driver" of performance and schedule. (Defense Systems Management College, 1997) CAIV policy became a major theme in the Department of Defense Directive (DoDD) 5000.1. It states that due to fiscal constraints, cost must be viewed as an independent variable, and program managers, after establishing aggressive cost goals, must trade off performance and schedule parameters to meet identified life cycle cost targets.

Dr. Kaminski, former Under Secretary of Defense, Acquisition and Technology (USD(A&T)), outlined the new CAIV "strategy" to develop and field affordable weapon systems. (Kaminski, 1995)

> This strategy uses the best value approach which requires that we thoroughly scrub program goals, not only for unnecessary military specifications, regulations, and data, but also—and more importantly—for marginal performance improvements that have little to do with actual combat effectiveness, but can drive up cost and schedule through unnecessary program risk. (Kaminski, 1995)

After releasing the CAIV memorandums, Dr. Longuemare, former Principal Deputy Under Secretary of Defense, Acquisition and Technology (PDUSD(A&T)),

nominated eight "Flagship" programs to closely monitor the implementation of the CAIV principles, share ideas, gather information, and assess the value of the CAIV policy. (Longuemare, 1996) The eight "Flagship" programs nominated by Dr. Longuemare are as follows.

- Army: ATACMS/BAT(P3I), Crusader
- Navy: **AIM-9X**, MIDS
- Air Force: SBIRS, JASSM, EELV
- Joint Strike Fighter

2. AIM-9X Program

The AIM-9X air-to-air missile program was chosen as a case study of the CAIV implementation process because of its status as a "Flagship" program. The missile is a major modification to the currently deployed AIM-9M Sidewinder (Figure 1-1).

Figure 1-1, AIM-9M Sidewinder

The Sidewinder is a launch and leave; air-to-air guided missile equipped with solid state electronics, which employs an infrared guidance control system. (U.S. Navy Program Guide, 1998) It is a Navy-led joint Navy and Air Force acquisition program.

The AIM-9X Sidewinder will employ focal plane array technology for its guidance control section, a highly maneuverable airframe, and signal processors that enhance its kinematics and infrared countermeasures capabilities. (U.S. Navy Program Guide, 1998) The missile is expected to provide U.S. fighters with air superiority into the next century. (U.S. Navy Program Guide, 1998) The Navy's F/A-18 C/D/E/F Hornet, and the Air Force's F-16 Fighting Falcon, F-15 Eagle, and F-22 aircraft are currently programmed to carry the AIM-9X Sidewinder. (AIM-9X SAMP, 1997)

The AIM-9X program office immediately began implementation of the new CAIV policy in December 1995. The AIM-9X program manager had to demonstrate successful CAIV implementation prior to DoD Milestone II approval to proceed into Engineering and Manufacturing Development (E&MD). The AIM-9X program continues to use CAIV in E&MD.

C. RESEARCH QUESTIONS

1. Primary research questions:

- Does CAIV have the attributes of a strategic management control system?
- In what ways does CAIV control the implementation of the acquisition reform strategy?

2. Secondary research questions:

- How did the AIM-9X program implement CAIV?

- What is the scope and function of the affordability Integrated Product Team (IPT)? How are decisions made? Who makes the final decision?
- What cost reduction activities did the program office engage in?
- Can the program quantify cost savings from CAIV implementation?
- What incentives did the program office and contractor use to influence behaviors and incentives?
- What standards did the program use to assess successful implementation of CAIV?

D. SCOPE, LIMITATIONS, AND ASSUMPTIONS

The scope of the thesis includes an overview of the DoD budget environment, a review of OSD CAIV policy, and a review of management control systems in DoD and in commercial industry.

The AIM-9X case study includes an embedded study of program management, and an embedded study of the program's Affordability IPT. The case study focuses on how the program office implemented CAIV, and what behaviors and incentives changed as a result of its implementation. The following case study discussion illustrates how CAIV is really a strategic management control system, and the ways in which the program office uses CAIV to control behavior, and ultimately the implementation of DoD acquisition reform strategy.

My understanding and analysis of the material in this thesis is influenced by my direct participation as AIM-9X requirements action officer for Director, Air Warfare (N88) staff for the Chief of Naval Operations.

E. RESEARCH STRATEGY AND METHODOLOGY

1. Analytical Strategy: A Five-Step Process

- Explain how environmental forces operating in DoD imposed a change in DoD acquisition strategy.
- Describe CAIV objectives, principles, and cost reduction activities.
- Review the use of management control systems in DoD and in commercial industry, then analyze CAIV from the perspective that it is a strategic management control system.
- Build an explanation of how the AIM-9X program implemented CAIV.
- Discuss findings from the AIM-9X case study to determine if CAIV has the attributes of a management control system, and in what ways it is used to implement strategy.

2. Methodology

a) Research for Analytical Strategy: Steps 1-3

Research in the following areas supports the first three steps of my analytical strategy.

- Unclassified Department of Defense publication and memorandums
- References, publications and electronic media (e.g., Defense Technical Information Center) available at the Naval Postgraduate School library
- Department of Defense internet websites
- Published academic books and papers

b) Research for Analytical Strategy: Steps 4-5

A case study of CAIV implementation into the AIM-9X program support steps four and five of my analytical strategy. The basic unit of analysis is the program office. Units of analysis embedded in the AIM-9X program office are the program manager, and the Affordability IPT manager. Units of analysis outside the AIM-9X program office include the Raytheon Defense Systems AIM-9X program manager, the current AIM-9X resource sponsor at Chief of Naval Operations, and the author's past experience as AIM-9X resource sponsor at Chief of Naval Operations. Table 1-1 ties together primary and secondary research questions, sources of evidence, and units of analysis.

Research Questions	Sources of Evidence	Unit of Analysis
Does CAIV have the attributes of a strategic management control system?	• DoD publication and memorandums • References, publications and electronic media • DoD internet websites • Published academic books	• AIM-9X program office • Affordability IPT • Raytheon program manager
In what ways does CAIV control the implementation of the acquisition reform strategy?	• AIM-9X case study	• AIM-9X program office • Affordability IPT • Raytheon program manager
How did AIM-9X implement CAIV?	• Documentation • Open-ended interviews • Focused interviews • Participant observation	• Program manager • Affordability IPT manager • Raytheon program manager • Resource sponsor
What is the scope and function of the Affordability IPT? How are decisions made? Who makes the final decision?	• Documentation • Focused interview • Organizational charts	• Affordability IPT manager
What cost reduction activities did the program office and contractor engage in?	• Focused interview • Open-ended interview • Focused interviews • Participant observation	• Program manager • Affordability IPT manager • Raytheon program manager • Resource sponsor
Can the program quantify cost savings from CAIV implementation?	• Program office cost estimates • Selected Acquisition Reports • Defense Acquisition Executive Summary	• Program office • Business financial manager
What incentives did the program office and contractor use to influence behaviors and incentives?	• Documentation • Focused interviews • Open-ended interview • Participant observation	• Program manager • Affordability IPT manager • Raytheon program manager • Resource sponsor
What standards did the program use to assess successful implementation of CAIV?	• Documentation • Focused interviews	• Affordability IPT manager • Raytheon program manager

Table 1-1, Summary of Sources of Evidence and Units of Analysis

F. ORGANIZATION OF STUDY

Chapter II provides an overview of the DoD environment in terms of a fiscally constrained budget, modernization requirements, and military performance requirements. The chapter discusses behaviors and incentives that result from these environmental forces and how a new acquisition strategy has emerged, which is an attempt to change behaviors and incentives and focus on developing and acquiring affordable weapon systems. The chapter then outlines strategic uncertainties, which threaten implementation of the new acquisition strategy.

Chapter III discusses in detail CAIV definitions, objectives, cost reduction activities, and functions of the Cost-Performance IPT. The chapter identifies ambiguous definitions of CAIV, and conflicting priorities in CAIV implementation between DoD CAIV policy and Department of the Navy CAIV policy. The chapter points out that the mere implementation of CAIV objectives is *not* a "conceptual approach," and that DoD does not provide a managerial framework to program managers for the implementation of CAIV.

Chapter IV is a review of the commercial industry approach to management control systems compared to the DoD approach to management control systems. The chapter develops a generic management control system model that I use later in Chapter VI to test the proposition that CAIV has the attributes of a strategic management control system. Additionally, the chapter describes Simons' framework of control systems, outlined in his book, *Levers of Control* (1995), which I also use in Chapter VI to describe the ways in which the CAIV control system implemented acquisition reform strategy.

Chapter V is the AIM-9X case study. The structure of the chapter parallels the DoD CAIV working group report's list of CAIV objectives. The chapter describes in

detail the history of the program's experience with CAIV implementation, and how it affected organizational behavior and incentives.

Chapter VI analyzes seemingly disjointed information from the AIM-9X case study using the two management control models discussed earlier in Chapter IV. The purpose is to illustrate that CAIV functions as a strategic control system, and is the managerial framework program managers need to implement DoD acquisition strategy. Chapter VII continues the analysis and discussion by highlighting three special issues—program ownership, cost models, and trade space—that program managers should consider during the implementation of CAIV into their programs

Chapter VIII summarizes research findings, lists major conclusions, and recommends areas for further research and study.

II. DOD ENVIRONMENT

A. OVERVIEW

This chapter describes the DoD environment in which CAIV operates. A first step toward evaluating CAIV implementation into the AIM-9X program is to understand how several forces within DoD shape the environment. The forces described in this chapter not only shape the environment, but significantly influence DoD weapons acquisition strategy, influence and incentivize participant's behaviors in implementing the acquisition strategy, and assist in identifying uncertainties of whether the strategy will succeed or not.

The following sections describe the DoD environment in terms of declining budgetary pressures, modernization requirements, military performance requirements, and acquisition reform initiatives. These forces significantly influence the formation of a new "cheaper, faster, better" weapons acquisition strategy. (Gansler, 1998)

B. BUDGETARY PRESSURES

The size of the defense budget has dramatically declined over the last decade. In 1985, at the peak of President Reagan's defense buildup, the DoD budget was $390B, or 6.2 percent of GDP. Today, President Clinton's FY 1999 defense budget is $257B, or 3.1 percent of GDP. The Budget Enforcement Act of 1990, which placed statutory caps on discretionary spending, the Bipartisan agreement between President Clinton and Congress to balance the budget by 2002, and the need to address long-term budgeting requirements for Social Security, Medicare, Medicaid, and the National Debt continue to place downward pressures on defense spending.

Between FY 1992 and FY 1996 national defense spending decreased a total of 11 percent, while during the same time frame total national expenditures rose 13 percent. (Congressional Research Survey Report, 1997) According to DoD DefenseLink, in the FY 1999 President's Budget, the DoD Future Years Defense Plan (FYDP) barely keeps up with projected inflation (Table 2-1).

$B	FY98	FY98	FY00	FY01	FY02	FY03
Total DoD	267.6	270.6	275.9	283.8	287.1	297.1
Real Growth	0%	-1.1%	0%	+.9%	-1.1%	+1.1%

Table 2-1, Total Spending in DoD 1998 Future Years Defense Plan
Source: DoD Defense Link (1998)

Defense budgeting affects behaviors and incentives in several ways. First, program managers compete with each other to keep their weapon programs funded within a fiscally constrained budget. DoD considers a program successful if individual service executives, Office of the Secretary of Defense, and Congressional Authorization and Appropriation committees annually approve funding for next year's installment. (GAO-T/NSAID-98-123, p.15)

Because approval must be secured every year, a program manager has an incentive to make the program look attractive as possible. (GAO-T/NSAID-98-123, p.17) Optimistic cost, schedule, and technology estimates help create a favorable image for a program. It is much easier for a program to obtain DoD approval and begin product development with optimistic cost estimates. DoD does not reward program managers for recognizing potential problems, and little incentive to admitting to higher risks than is necessary. (GAO-T/NSAID-98-123, p.17)

As a program proceeds through E&MD, and comes closer to production, the incentive for program managers to present optimistic information intensifies. (GAO/NSAID-93-15, p.45) The program commands increasing funds and faces criticism from every level of DoD. Program managers, and their sponsors, have a deposition to protect the program from disruption. (GAO/NSAID-93-15, p.46) In the face of criticism, a developmental weapon program is "pulled" through to completion by its advocates. At the same time, a program continually competes for annual funding with other programs being "pushed" into the budget by its advocates. (GAO/NSAID-93-15, p.47)

As defense appropriations decrease, a manager has the incentive to accept even greater risk, in terms of optimistic cost, schedule, and technology estimates. A manager's incentive is to maintain funding, and remain in the budget in a fiscally constrained, competitive environment. (GAO/NSAID-93-15, p.2)

Lastly, in an environment with intense budgetary pressures, a program manager's behavior reflects that of a program advocate, who is "selling" the program. (GAO/NSAID-93-123, p.15) A 1994 Defense Systems Management College study conducted for the Under Secretary of Defense for Acquisition and Technology found that a program manager's behavior reflected that of a program advocate. (GAO-T/NSAID-98-123, p.16)

During the coarse of program development over 40 line and staff participants have veto power over the program. (Gansler, 1991, p.147) A program's budget request must survive repetitive reviews from the service comptrollers, service secretaries, OSD secretaries, Office of Management and Budget (OMB), and four congressional

committees. Each program must successfully pass a Defense Acquisition Board review in which parts of the review--Operational Test reports and independent cost estimates--are beyond the program's control. (Gansler, 1991, p.146) At every step of program development, there are participants in the process challenging the validity of the program's cost, schedule, and performance parameters. A Program Manager protects, advocates, and "sells" the program to ensure its continuance. Program managers, and its sponsors, realize that bad news can tip the argument in favor of their critics, leading to reduced funding or termination. (GAO/NSAID-93-15, p. 47)

C. MODERNIZATION

Because of budget reductions, DoD has delayed force modernization over the last decade. The Department's reductions in spending have come disproportionately from reductions in procurement spending. Between FY 1985 and FY 1997 DoD weapon procurement accounts have declined in real terms by 70 percent. (Congressional Research Survey Report, 1997) The decision to cut weapon procurement so drastically reflects changing national priorities initiated by the Bush Administration, and continued by the Clinton Administration, after the end of the Cold War (Figure 2-1). This approach was also possible because of the large quantities of modern equipment purchased during the 1980s under the Reagan Administration. (DoD QDR, 1997)

DoD Total Obligated Authority
FY81 - FY99

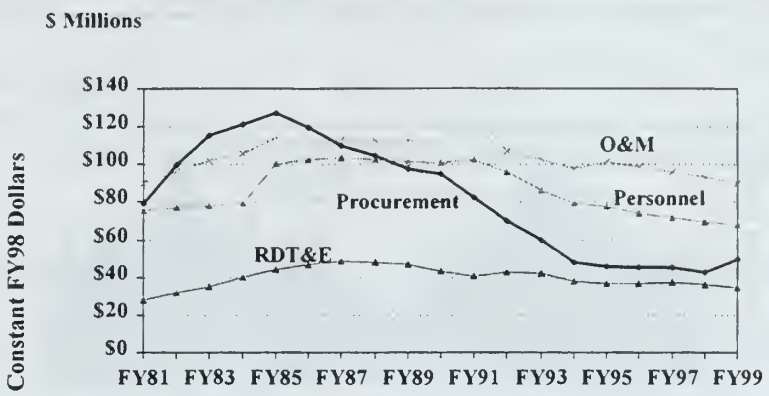
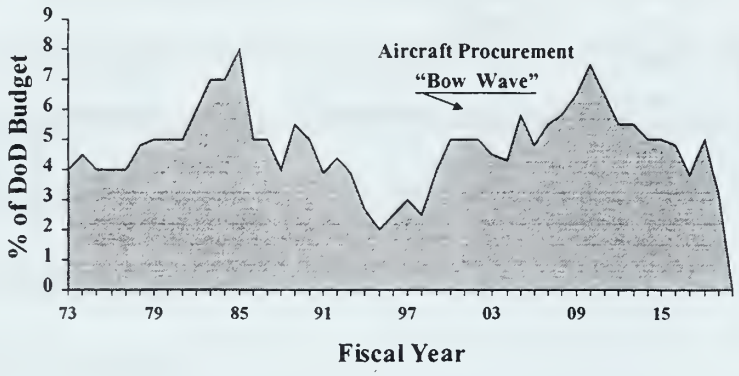


Figure 2-1 Source: USD(C) Green Book

The downside of reducing the Department's programmed procurement is delayed modernization, and accumulation of a demand for longer term commitments of military equipment and hardware, known as the "bow wave". (DoD QDR, 1997) Many weapons systems and platforms purchased in the 1980s will reach the end of their useful lives over the next decade. The result is a requirement to increase procurement funding to replace older equipment. Figure 2-2 illustrates what looks like a "bow wave" of funding required for aircraft purchases beginning in FY 1996, and peaking in FY 2010, as expressed by the percentage of total DoD Budget Authority dedicated to aircraft procurement. In FY 1996, aircraft procurement was 2.6 percent of total DoD Budget Authority, whereas in FY 2010 aircraft procurement will make up nearly 8.0 percent of total DoD Budget Authority. (GAO/NSAID-97-88, p. 8)

Funding for Aircraft Purchases as a Percentage of DoD Budget



Source: GAO/NSAID 97-88
Defense Aircraft Investments

Figure 2-2

In the last several years the Defense Department has shifted focus away from managing large budget reductions in total spending to finding methods to modernize its existing force structure. Despite budgetary pressures that keep total DoD spending flat through at least FY 2001, the Department has established a goal of increasing weapon procurement funding to roughly $60 billion by FY 2001. (DoD QDR, 1998)

The Quadrennial Defense Review examined U.S. security threats, defense posture, and force structure requirements for the post-Cold War era, and detailed a plan to ensure that the U.S. could meet its goal to modernize U.S. weapons. In the FY 1999 President's Budget, DoD increased weapon procurement funding to support implementation of Quadrennial Defense Review recommendations (Table 2-2).

$B	FY99	FY00	FY01	FY02	FY03
QDR Goal	49.0	54.0	60.0	61.0	62.0
FY1999 Budget	48.7	54.1	61.3	60.7	63.5

Table 2-2, QDR Goals and FY 1999 President's Budget
Source: DoD Defense Link (1998)

The challenge facing DoD today is how to fund increased weapon procurement, and modernize U.S. defense forces, when current budget projections remain flat. Military requirements that drive the QDR goal to increase procurement funding up to $60B will be extremely challenging to meet in a fiscally constrained environment.

Modernization of U.S. defense forces is a requirements decision, which will directly affect costs. It is an organizational decision, based upon individual behaviors and incentives. DoD has a made a requirements decision to develop and produce new weapon systems rather than upgrading existing ones, or extending the service life of existing weapon systems (i.e., F-22, V-22, SSN-21, Seawolf, DD-21, Joint Strike Fighter, F/A-18E/F, Comanche Helicopter).

The defense programs mentioned above have fiscal resources programmed and budgeted into the Future Years Defense Plan for their development. However, as discussed previously, the constrained budget environment encourages program managers to accept optimistic cost, schedule, and technology estimates, which suggest these modernization programs will be more expensive than planned.

GAO research showed that unanticipated cost growth in DoD has averaged at least 20 percent over the life of a weapon program. (GAO/NSAID-97-103, p.2) The cost growth is attributable to longer than anticipated development and production schedules.

(GAO/NSAID-97-103, p.2) The same report states that rather than outright cancellation of programs in order to fund the higher priority programs, service executives choose to sustain weapon programs by longer development schedules and reduced procurement rates, which lead to increased unit and life cycle costs. The report is critical of a DoD "business as usual approach," and makes the following comment.

> We found DoD's optimistic acquisition strategies are rarely achieved because of DoD's decisions to fund new programs in low-rate initial production and to reduce funding for programs in full rate production. Consequently, weapon systems are produced at less than planned rates, causing schedules to be stretched out and increasing costs by billions of dollars. (GAO/NSAID-97-103, p.2)

GAO presents evidence that program schedule estimates may not be reasonable. Table 2-3 summarizes the length of time between program initiation and fielding of initial units on 32 weapon systems in production and deployed on December 1991. (GAO/NSAID-93-15, p.20)

Type of program	Avg planned length (yrs)	Average actual length (yrs)	Average total delay (yrs)	Average increase (%)
All programs (32)	8.53	10.49	1.96	22.94
Aircraft(11)	8.36	9.75	1.39	16.57
Ground Vehicles (3)	6.75	8.67	1.92	28.38
Missiles (10)	8.97	11.47	2.50	27.86
Ships (3)	7.36	9.17	1.81	24.57
Other (5)	9.75	11.98	2.23	22.91

Table 2-3, Delays in Major Weapon System Programs
Source: GAO/NSAID-93-15

The same GAO report states that costs and schedules grow together. (GAO/NSAID-93-15, p.21) Costs grow as a result of optimistic assumptions about planned production rates, savings from competition, material costs, exclusion of relevant program costs such as training equipment, and the magnitude of the technological effort. Schedules grow because of optimistic assumptions about the risks associated with the technology required to meet performance requirements. (GAO/NSAID-93-15, p.22)

GAO is critical of DoD's tendency to underestimate program costs, which has resulted in more programs being started than can be executed. (GAO/NSAID-93-15, p.21) Fiscal constraints and optimistic estimates cause production schedules to be stretched, which lead to further increases in program costs.[1] Additionally, the gap between projected funds and actual funds in the FYDP further complicates DoD plans to fund modernization programs. (GAO/T-NSAID-97-103, p.2; GAO/NSAID-93-15, p.22)

D. MILITARY REQUIREMENTS

The U.S. defense industry has historically been driven by technology not costs. (Gansler, 1980, p.11) The technology paradigm made explicit that U.S. weapons, in the face of Soviet numerical superiority, would be superior in technology, capabilities, and performance requirements. Despite the collapse of the Soviet Union, and any significant military threat to this country, the military requirement to build only the most technologically superior weapons continues to drive weapon programs in today's post-Cold War Era. Defense Secretary Cohen, and the Joint Chiefs of Staff, argued for this

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[1] A few examples from GAO reports: Army's Javelin production schedule increased 6-10 years at a cost of $1B, Navy's V-22 program 3 years behind schedule and unit cost increase to $40M (GAO/NSIAD-93-15), GAO/T-NSAID-97-103, page 2 and GAO/NSAID-93-15, page 22.

approach in the Quadrennial Defense Review by citing "asymmetric threats"(i.e. low cost cruise missiles and nuclear, chemical, biological weapons), and Russian exports of its leading edge weapons technologies to Third World countries as threats to national security. The Quadrennial Defense Review continues to demand only the most technologically advanced weapons for the military user. (DoD QDR, 1997)

The result is a culture that exists among military requirements officers, defense officials, and defense contractors, who freely expect increased weapon capabilities with little regard towards cost. (Gansler, 1991, p.122) GAO continually questions the costs of high technology performance requirements specified by the military requirements community, and, for example, their need for F-22, V-22, F/A-18E/F, AV-8B, and JSF in the face of a diminished threat. (GAO/HR-95-4, p.6) Cost considerations play a secondary role in the military culture for several reasons.

First, users want to reinforce the impression that there is a valid and legitimate need for the weapon. (Farrell, 1997, p. 82) Each weapon system has a set of operational performance requirements that state what the final product should do. The user often presses for detailed performance requirements early in the development cycle to reinforce the need for the weapon. However, setting detailed performance requirements early in a weapon development cycle may restrict optimal, less costly solutions. The user has little incentive to trade off performance requirements for less costly solutions when a legitimate, validated military requirement exists.[2]

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[2] From my experience on the Chief of Naval Operations staff the requirements validation process is exhaustive for Major Defense Acquisition Programs. The Operational Requirements Document is signed by the military service chief only after a lengthy internal review process, then is subject to external review by the Joint Requirements Oversight Council. The Vice-Chairman, Joint Chiefs of Staff, chairs the Joint Requirements Oversight Council. The Joint Requirements Oversight Council reviews and validates a

If the user begins trading off operational requirements, then the requirement was not so urgent and required after all. Farrell accurately points out that lowering operational requirements would undermine the institutional alliance and consensus building required for getting a weapon approved for development and production. (Farrell, 1997, p.82)

Historically, rather than make a cost-performance tradeoff, the military requirements culture pushes for the greatest possible technological performance regardless of cost, often "gold-plating" the operational requirement. (Farrell, 1997, p.83) Gansler states that the result is the user turning over an overspecified and underfunded requirement to the acquisition community for development. (Gansler, 1991, p.147)

Second, detailed performance requirements is also a way requirements officers can protect favored leading edge technologies, which they do not want to trade away. A GAO report found that, unlike commercial companies, DoD programs allow technology development to continue into product development, then understate the risk present. (GAO-T/NSAID-98-123, p.15) For example, several key technologies are still immature and unproven in the F-22, and will not be proven until 40 aircraft have been produced. The C-17 had less than 60 percent of its engineering design completed prior to its critical design review; the F-22 had less than a 33 percent completed. (GAO-T/NSAID-98-123, p.9) In the competition for annual funding, the program manager has incentives to accept

---

program's key operational requirements, schedule, and cost parameters. The military requirements community questions, reviews, and validates every requirement in the Operationaal Requirements Document, as a legitimate defense force structure need. Cost/benefit analysis, called the Analysis of Alternatives, must support all requirements, and all assumptions in the cost/benefit analysis are questioned during the review process. The acquisition community is then tasked with developing and producing the weapon system.

more unknown, immature technologies to meet more of the detailed operational performance requirements. (GAO-T/NSAID-98-123, p.15) The military requirements culture encourages this behavior because it enhances weapon performance vis-a-vis the threat, which is why the weapon is developed in the first place, and it further legitimizes the performance requirement.

The AIM-9X program is certainly not immune from the technology paradigm. Table 2-4 summarizes Sidewinder's evolutionary history, and Figure 2-3 charts the cost history of the AIM-9H Sidewinder to the current AIM-9X Sidewinder development program. (Data Search Associates, 1997)

Missile	User	Operational	Evolution and contractors
AIM-9B	Navy/AF	1956	First operational Sidewinder. Built by Ford and General Electric.
AIM-9D	Navy	1965	Advance AIM-9B. Built by Ford and Raytheon.
AIM-9G	Navy	1966	Same as AIM-9D, but with addition of advance acquisition mode. Built by Raytheon.
AIM-9H	Navy	1970	Solid state version of AIM-9G. Built by Raytheon and Ford.
AIM-9L	Navy/AF	1975	New guidance control section, safe & arm device, and fuze. Built by Raytheon and Ford.
AIM-9M	Navy/AF	1981	New guidance and rocket motor. Built by Raytheon and Ford.
AIM-9X	Navy/AF	2002	New guidance and maneuvering capabilities. Built by Raytheon and Ford.

Table 2-4, AIM-9 Sidewinder Evolutionary History
Source: NAWCWPNS TM 6798, 1997

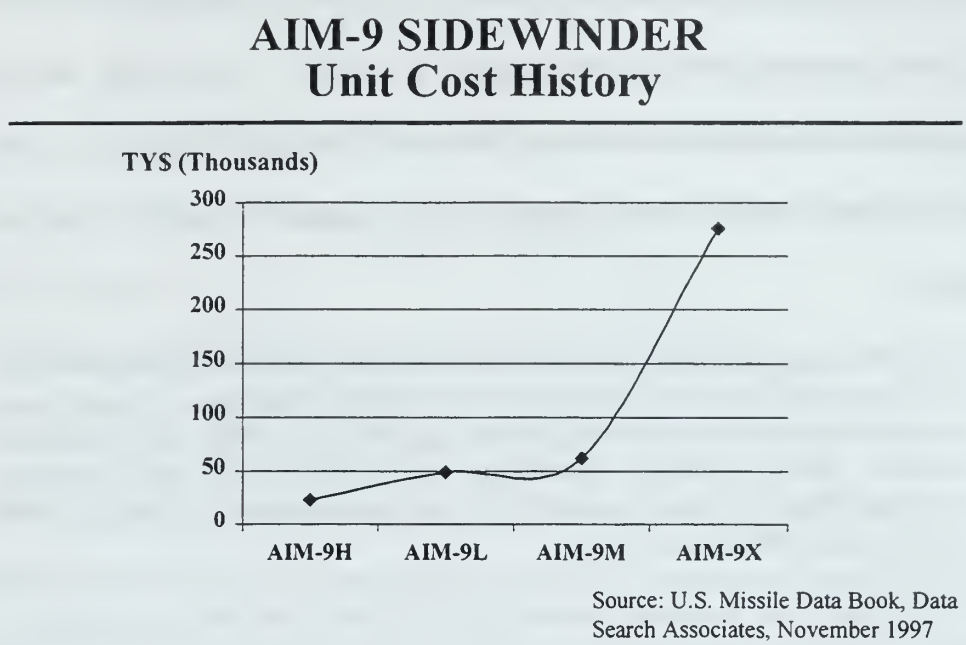


Figure 2-3

E. ACQUISITION REFORM STRATEGY

The previous sections described the DoD environment in terms of declining budgetary pressures, modernization, and a military requirements culture. These environmental forces influence participant's behaviors, which affect decisions regarding costs. They also have imposed upon DoD a need to change the way it conducts business, if it is to afford modern weapons. (DoD, QDR, 1997) Dr. Gansler (USD(A&T)), in remarks from his keynote address to an Executive Acquisition Symposium, highlights the need for change:

> A major issue is how to pay, within a constrained budget, for required weapons modernization. To do this, government must take full advantage of the technologies and management lessons that U.S. commercial industry has evolved over the last decade, and, weapons must be developed at a lower cost and within drastically reduced cycle times. (Gansler, 1998)

1. Acquisition Strategy

The FY 1999 defense budget projects an increase in procurement spending, but total defense spending remains flat through FY 2003. Dr. Gansler states that a fundamental transformation in the way DoD does business is required to make this happen. The following DoD vision statement is a mandate for change in the acquisition community.

> DoD will institutionalize business processes that facilitate timely delivery of "best value" products and services that meet the warfighters' needs; and an environment for continuous process improvement; while supporting the nations social policies, protecting the public trust and fostering development of an integrated U.S. national industrial and technology base. (USD(A&T) Webpage, 1998)

Additionally, six acquisition reform goals outline what DoD is to achieve.

- Enhance the requirements determination process
- Improve the systems acquisition effectiveness
- Improve the procurement process
- Improve contract administration
- Improve government contract terms and conditions
- Change the culture (USD(A&T) Webpage, 1998)

For purposes of this thesis, I define acquisition strategy as the integration of the vision statement and goals into one, overarching strategy. The new strategic direction is succinctly summarized by Dr. Gansler's remarks to the National Contract Management Association. The "overall acquisition goal must be to do the job better, cheaper, and faster." (Gansler, 1998) The change in acquisition strategy guides the entire process and provides a road map on how to manage and control programs.

2. Focus on Affordability

In the QDR preface, Secretary Cohen states that fiscal reality "focused our attention on the need to reform our organization and the methods of conducting business." (DoD QDR, 1997) The conclusion is that previous behavior-related cost activities are no longer affordable. DoD realizes that it cannot continue to conduct "business as usual."

Many of the proposed weapon systems look unaffordable (e.g. F-22, V-22, F/A-18E/F, Joint Strike Fighter). For example, GAO concludes that DoD's aircraft investment strategy may be unrealistic. Between FY 2000 and FY 2015 Defense expenditures for aircraft, as a percentage of total DoD budget, will exceed the historical average in all but one year (Figure 2-4). For several of those years the percentage will approach the peak of Cold War era spending. (GAO/NSAID-97-88, p.2) GAO concludes that because of historical cost growth in DoD programs, "if the additional funding and the projected savings do not materialize as planned, DoD will face a significant imbalance" between funding requirements and fiscal resources. (GAO/NSAID-97-88, p.3)

Historical Average of Aircraft Purchases as a Percentage of DoD Budget

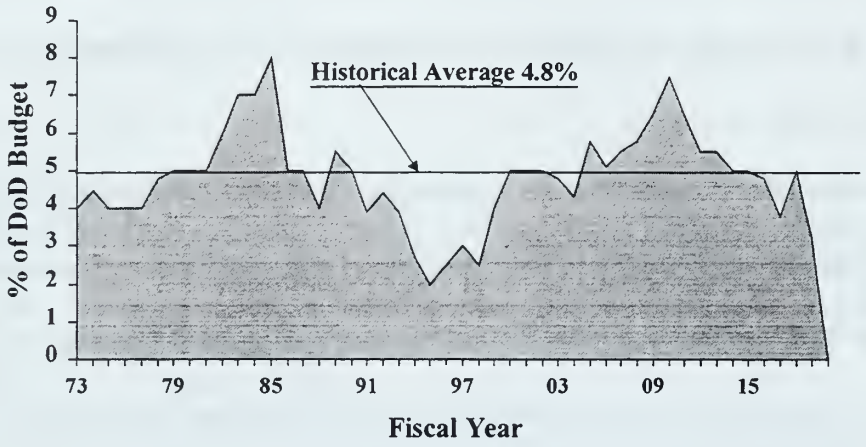


Figure 2-4

Source: GAO/NSAID 97-88
Defense Aircraft Investments

3. Acquisition Reform Initiatives

The focus of DoD acquisition reform efforts is to make modernization programs affordable. Initiatives include use of single process initiative, reduction in military specification, use of Joint programs and commonality, logistics support reform, use of commercial standards, regulatory waivers, contractor configuration control, and CAIV. (DoDD 5000.2R, 1996)

DoD leadership has increasingly pointed to CAIV as one of its more important acquisition reform initiatives. In a statement to the House Committee on National Security on Defense Acquisition Reform, Dr. Kaminski, former Deputy Under Secretary for Acquisition and Technology, commented,

> Significant savings are possible. For new programs using CAIV from the onset, savings on the order of 30-50% can be obtained. For existing

> programs in later acquisition stages, retrofitting CAIV concepts is expected to produce savings on the order of 10-20%. (Kaminski, 1997)

F. STRATEGIC UNCERTAINTIES

DoD is attempting to change its acquisition strategy to meet modernization requirements in a fiscally constrained environment, but uncertainties threaten the implementation of acquisition strategy. The Quadrennial Defense Review, DoD leadership, and recent GAO reports all acknowledge the presence of strategic uncertainties, which threaten the plan to help fund modernization through cost savings generated by acquisition reform.

The Quadrennial Defense Review identified technical risk in leading edge development efforts, cost growth, and complex advanced programs as sources of strategic uncertainty.

> The technical risk and program uncertainty inherent in complex, leading-edge development efforts lead to unavoidable growth in costs and offsetting reductions in other programs. Complex, technologically advanced programs all bear some risk of costing more than planned. When unforeseeable growth in costs occurs, offsets from other programs must be found, this in turn disrupts the overall modernization program. (DoD QDR, 1997)

Donna Richbourg, Acting Deputy Under Secretary of Defense (Acquisition Reform) identified the smaller economic base, differences in mission, and evolving technologies as sources of strategic uncertainty. "We are actively pursuing actions that will reflect cost effectiveness in all actions relating to modernization of DoD weapon systems." (GAO-T/NSAID-98-31, p. 20)

In an effort to avoid potential uncertainties identified by the Quadrennial Defense Review and Donna Richbourg, program managers are incentivized to start programs with

overly optimistic cost, schedule, and performance baselines. (GAO-T/NSAID-98-123, p.17) An individual program faces continual uncertainty in the annual budget process and forces the program manager to continually "sell" his program. (Gansler, 1991, p.148) The effect is to introduce further uncertainty into the process about the real cost of a weapon system. As costs grow and programs become under funded, competition among stakeholders for scarce resources increase. In an almost circular argument, rather than cancel weapon programs as too costly, DoD stretches programs out, which further increases unit costs. (GAO-T/NSAID-98-123, p.15)

G. SUMMARY

The previous sections outlined forces in the DoD environment, which influence behaviors and incentives, and lead to higher costs. Constrained budget pressures drive federal budget authority and outlays for defense spending down. Programs are stretched out rather than cancelled, and unit costs increase. The requirement to modernize defense forces, as approved by the Quadrennial Defense Review, drives up appropriations for weapon procurement. Modernization of weapons equipped with leading edge technologies drive up unit costs.

Similarly, the military user's continued reliance on only the most technologically advanced weapon systems drive costs up. This paradigm has created a culture among military requirements officers, defense officials, and defense contractors, that performance is more important than cost. Acquisition reform efforts, specifically CAIV, attempt to address behavior-related activities that lead to higher weapon systems costs.

DoD's new acquisition strategy is to change the way of doing business and build weapons faster, cheaper, and better, but strategic uncertainties threaten the strategy's

DoD Environment

Figure 2-5

implementation. If the processes, attributable to CAIV by DoD literature, are successful in changing the behaviors and incentives that lead to higher costs, then modernization may be affordable during a fiscally austere time. The next chapter describes DoD CAIV policy, objectives, cost reduction activities, the use IPTs, and includes specific criticism of CAIV.

III. COST AS AN INDEPENDENT VARIABLE

A. OVERVIEW

This chapter outlines CAIV definitions, objectives, cost reduction activities, and CPIPT functions. Implementation of CAIV represents a departure from past DoD practices and is an attempt to change the behaviors and incentives that lead to higher costs. However, the existence of different CAIV definitions and cost reduction priorities indicates that CAIV lacks a managerial framework to assist program managers in how to think about it.

B. DEFINITION

The reader may not find one complete definition of CAIV, but rather many definitions of CAIV. The DoDD 5000.1 defines CAIV as follows.

> Cost must be viewed as an independent variable. Accordingly, acquisition managers shall establish aggressive but realistic cost objectives for all programs and follow through by trading off performance and schedule, beginning early in the program (when the majority of costs are determined), to achieve a balance set of goals, based on guidance from the Milestone Decision Authority. (DoDD 5000.1, 1996)

Chapter I outlined Dr. Kaminski's definition of CAIV as a "strategy that uses the best value approach." Additionally, the following samples from the literature simultaneously describe CAIV as follows *(italics are mine)*.

> DoDD 5000.2R defines, "CAIV is a *process* that helps arrive at cost objectives." (DoDD 5000.2R, 1996)

> Dr. Conrow from DSMC writes, "the recent OSD cost as an independent variable (CAIV) *initiative* takes a step in a different direction – it attempts to address several key issues that lead to increased program cost and schedule." (Conrow, 1996, p.48)

> Mr. B.A. Kausal IV from DSMC also writes, "the latest DoD *initiative* to try and tackle this problem (affordability) is Cost As An Independent Variable." (Kausal, 1996, p.22)
>
> The Department of the Navy (DON) acknowledges existence of widely varied CAIV definitions and, in addition to DoD policy, has issued its own policy guidance. (Dalton, 1998) DON policy describes CAIV as a "*strategic management process*" and as a "*methodology* for reducing total ownership costs." (Dalton, 1998)
>
> Dr. Rush from DSMC writes, "CAIV is a new DoD *strategy* that makes total life-cycle costs as projected within the new acquisition environment a key driver of system requirements." (Rush, 1997, p.165)
>
> Finally, Dr. Land from DSMC writes, "CAIV is an acquisition *philosophy* intended to integrate proven successful, business-related practices with new DoD initiatives to obtain superior, yet reasonably priced warfighting capabilities." (Land, 1997. P.26)

Remarks made by Dr. Kaminski, former USD (A&T), at an Air Force acquisition work force CAIV conference present still another definition of CAIV. (USAF CAIV Conference, 1997) He emphasized that CAIV is meant to simulate the commercial sector's use of *target costing methodology* inside DoD. Target costing is a strategic cost management method used in product design that involves estimating a target cost for a new product, then designing the product to meet that cost. Dr. Kaminski noted that "CAIV involves the user, sustainer, and acquirer in looking for cliffs." (USAF CAIV Conference, 1997) Five percent of the performance may be worth fifty percent of the cost. He proposed that the financial departments get involved early and flip back and forth between cost, performance, design, and schedule.

A program manager might conclude that implementing CAIV into programmatic management is a difficult task since CAIV has so many definitions. Dr. Rush goes on to say that CAIV suffers from too many initiatives to be easily explained. It is a philosophy,

which combines all best practices affecting cost. (Rush, 1997) Although ambiguous definitions of CAIV exist in DoD literature, a description of its objectives is clear, which is the subject of the next section.

C. OBJECTIVES

Dr. Longuemare, former PDUSD(A&T), states the thrust of CAIV is to adapt successful business practices that meet or exceed the military user needs, while meeting specific, predetermined cost targets. (Longuemare, 1995) In the past, the Soviet threat and available technology drove the acquisition process, and cost-performance tradeoffs were not emphasized. (Longuemare, 1995) CAIV formalizes a process to facilitate cost-performance tradeoffs that include the military user, contractor, and logistician as participants. (Longuemare, 1995)

Although Dr. Rush states that "the central feature of CAIV is the tradeoff process," the DoD CAIV working group report (1995) establishes a "broader context" for CAIV. The working group report provides the "conceptual approach" to CAIV by listing a set of objectives the program manager can "utilize and enlarge" upon in its implementation. Program management should achieve the following objectives.

- Set realistic, but aggressive cost objectives early in an acquisition program
- Manage risks to achieve cost, schedule, and performance objectives
- Devise appropriate metrics in tracking progress towards achieving cost goals
- Motivate government and industry managers to achieve program objectives
- Put in place for fielded systems additional incentives to reduce operating and support costs. (Longuemare, 1995)

The following subsections explain each of the objectives in more detail.

1. Setting Aggressive Cost Objectives

The DoD CAIV working group report (1995) describes aggressively setting cost objectives, ensuring projected out-year resources are balanced with mission needs, and a willingness to trade-off operational performance to meet cost objectives as keys to a successful CAIV program. The program manager sets cost objectives that are DoD-equivalent of sound commercial business practices based upon costs of comparable systems, mission effectiveness studies, technology based trends, and initiatives such as lean manufacturing. DoDD 5000.2R (1996) states that the Cost-Performance IPT will update the cost objectives during each phase of development to ensure realism is balanced with aggressive cost objectives.

> Setting aggressive cost objectives and a revitalized and more formal cost-performance tradeoff process will motivate both government and industry by clarifying objectives, fostering feedback, and empowering decision-making at the lowest levels. (Longuemare, 1995)

2. Manage Risk

The working group stated in their report that a program must integrate any CAIV implementation plan with a risk management plan. Attempting to achieve aggressive cost objectives could increase program risk. A CAIV plan that uses mature technologies, conducts cost/performance/schedule/risk tradeoffs, and identifies solutions to manufacturing process uncertainties can decrease program risk.

DON CAIV policy states, "an unavoidable consequence of setting aggressive, realistic cost objectives is an increase in risk". (Longuemare, 1995) Dr. Rush lists areas of program management that is particularly important when attempting to decrease risk during the implementation of CAIV.

- Program budgets remain stable since they are critical under CAIV, where cost explicitly drives performance and schedule.
- Operational requirements remain stable during system development and production.
- Cost models can determine relationships between performance, mission effectiveness, and cost, and the relationships are used in the tradeoff process.
- Historical cost database is applicable to accurately predicting the cost of the current system.
- Technology develops as required to enable achievement of design and process goals. (Rush, 1997, p.147)

Although Dr. Rush lists several more areas of risk management, the above list is applicable to the AIM-9X case study.

3. Incentives for Achieving Cost Objectives

Each acquisition program must incentivize government and contractor employees to meet or exceed cost objectives. The CAIV working group suggests government program managers establish an environment that promotes teamwork, goal setting, and recognition of accomplishment from the management chain. For industry, the working group acknowledges that current source selection practices put too much emphasis on performance, with less emphasis given to reducing production and/or operations and support costs.

DoDD 5000.2R (1996) now includes the following CAIV working group recommendations. The Request for Proposal must provide incentives to the contractor to meet or exceed cost objectives. Programs must maintain competition and let the business

profit incentive work as long as practical. Program managers must use award programs and shared savings programs to create incentives for the contractor to continue to reduce costs throughout the life of a program. Finally, the contract approach will consider incentive and award fee structures to decrease life cycle costs.

4. Metrics

Metrics and observables are needed for overall assessment of progress in applying CAIV to an acquisition program. A system of quantitative measurements facilitates oversight of CAIV implementation and management of achieving objectives. Table 5-1 provides a sample of metrics from the DoD working group report that program management must consider when implementing CAIV.

• Are cost objectives defined and consistent with requirements programmed and projected fiscal resources?	– Out-year resources ($) identified? – Production and operations and support cost objectives included in the Request for Proposal? – Key tradeoff issues addressed? (e.g., in Analysis of Alternatives)
• Is DoD managing to achieve cost objectives?	– Request for Proposal contains a strict minimum number of performance specifications? (#) – Cost-Performance IPT functioning; tradeoff space identified in program baseline and RFP? – Risks to achieve cost objectives identified and program steps to address these defined? (risk plan) – Incentives for achieving cost objectives included in the Request for Proposal and contract? (% relative to total contract $s) – Mechanism for contractor suggestions to reduce production and operations and support costs in place and operating? – Allocation of cost objectives provided to IPTs and key suppliers – Measurement and estimation of reliability and maintainability – Robust contractor incentives plan in place?
• Are contractors managing to achieve cost objectives?	– Providing appropriate tools for cost-performance tradeoffs (including incentives for corporate management) and participates in cost-performance tradeoff process – Identifying (and when appropriate implements) new technologies and manufacturing processes that can reduce costs – Identifying procedural/process impediments to cost reduction measures – Establishing strong relationship with vendor base, including sound incentives structure

Table 3-1, Illustrative CAIV Metrics and Observables
Source: DoD CAIV Working Group Report (1995)

5. Fielded Systems

The CAIV working group recommends program management establish awards board to recognize proposals that would reduce total life cycle costs. The award board would rank the proposals by return on investment, risk, and other considerations.

Program managers can achieve the objectives by employment of various cost reduction activities described in the next section.

D. COST REDUCTION ACTIVITIES

According to the new DoD CAIV policy, cost is the key driver of performance and schedule. Defense Systems Management College proposes a hierarchy of cost reduction activities available for CAIV implementation. The following list presents CAIV reduction activities in order of potential benefit.

- Cost/performance/requirements trades—considered the "essence" of CAIV
- Acquisition strategy—maintain competition as long as possible
- Systems engineering/Integrate Program and Product Development—integrate all functional planning
- Contractor enterprise re-engineering—concentrate on core activities and develop key suppliers for non-core activities
- Commercial specifications, practices, and components where technically feasible. (Defense Systems Management College, 1997, p.14-4)

The DON CAIV policy includes still another hierarchy of cost reduction activities. (Dalton, 1998) The DON list is also presented in recommended order of priority.

- Analyses should be continuously performed to improve processes and activities, and to eliminate non-value added and deficient cost-to-benefit processes and activities. Value-based technology solutions should be implemented throughout the life cycle to minimize cost.
- Requirements, which do not directly contribute to warfighter's needs, should be scrutinized for relaxation during the Analysis of Alternatives and throughout the life cycle.
- Tradeoffs that reduce cost while still meeting all operational requirements should be conducted during the life cycle.
- Cost performance tradeoffs of user requirements resulting in a breach of the operational requirement threshold are only to be accomplished as a last resort, with agreement of the Milestone Decision Authority and Chief of Naval Operations or Commandant of the Marine Corps.

The priority of cost reduction activities differs between DoD and DON, which sends conflicting signals to program managers and can further weaken the implementation process in DoD. According to DSMC the essence of CAIV is the cost/performance/schedule tradeoff, whereas DON policy puts requirement trades as a lower priority.

E. COST-PERFORMANCE IPT

The mechanism by which CAIV is implemented is through the formal organization and activities of an acquisition program's Cost-Performance IPT. (Kaminski, 1995) DoD has made IPTs an integral part of the defense acquisition oversight and review process. (DoD Guide to IPPD, 1996) Their purpose is to replace a

sequential process of review and approval with a teaming concept. (DoD Guide to IPPD, 1996) The following subsections describe the focus and responsibilities of IPTs, the hierarchy of IPTs, and specifically, the Cost-Performance IPT function and responsibilities.

1. IPTs

a) Functions

The purpose of IPTs is to facilitate decision-making by making recommendations based on timely input from the entire team. Composition of IPTs includes representation of all appropriate functional disciplines, which takes advantage of their expertise, and enables a faster approval process during milestone review. (DoD Guide to IPPD, 1996) IPTs operate under the following broad principles:

- Open discussions with no secrets
- Qualified, empowered team members
- Consistent, success-oriented, proactive participation
- Continuous "up the line" communications
- Reasoned disagreement
- Issues raised and resolved early (DoD Guide to IPPD, 1996)

b) Hierarchy of IPTs

Hierarchies of IPTs exist for each acquisition program. (DoD Guide to IPPD, 1996) Figure 3-1 illustrates a program's IPT structure. In the program

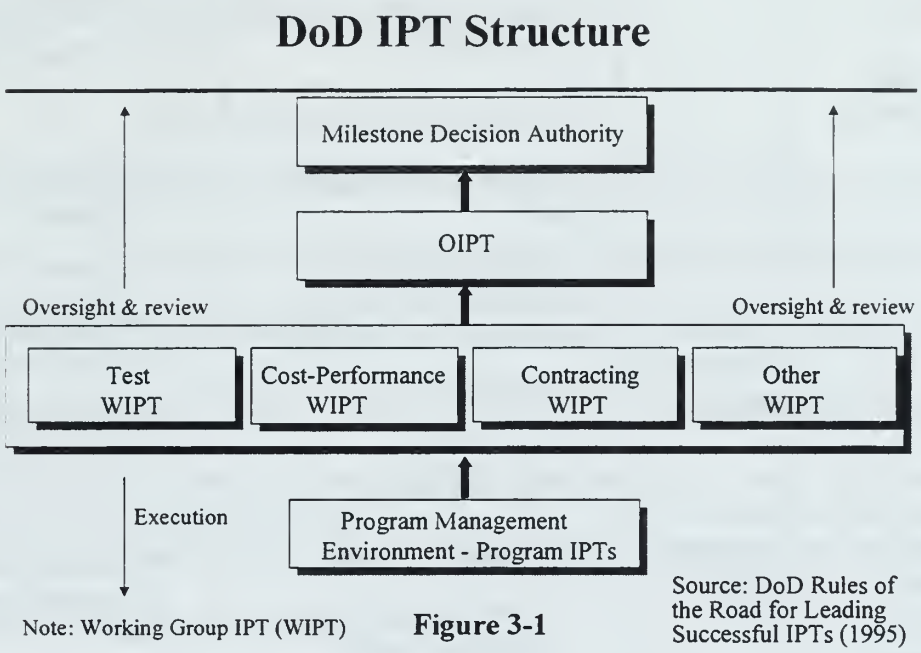


Figure 3-1

management environment there exist the program IPTs, which are responsible for program execution. At the next level, a series of working group IPTs exists that focus on identifying and resolving issues, taking advantage of acquisition reform opportunities, and planning for program success. Together the working group IPTs perform the function of integrating all program information, issues, and resolutions geared towards program success. Just below the Milestone Decision Authority, the Overarching IPT provides strategic guidance and program assessment. Table 5-2 depicts the types and functions of each IPT.

Organization	Teams	Focus	Participant Responsibilities
OSD and Components	Overarching IPT	• Strategic guidance • Tailoring • Program assessment • Resolve issues elevated up from WIPTs	• Program success • Functional area leadership • Independent assessment • Issue resolution
	Working IPTs	• Planning for program success • Opportunities for acquisition reform (e.g., innovation, streamlining) • Identify/Resolve program issues • Program status	• Functional knowledge & experience • Empowered contribution • Recommendation for program success • Communicate status & unresolved issues
Program office & system contractor teams	Program IPTs	• Program execution • Identify & implement acquisition reform	• Manage complete scope of program, resources & risk • Integrate government & contractor efforts for program success • Report program status & issues

Table 3-2, DoD IPT Types, Focus, and Responsibilities
Source: DoD Guide to IPPD (1995)

2. Cost-Performance IPT

a) Functions

The Cost-Performance IPT is a working level IPT, which provides oversight and review of an acquisition program. (DoD Guide to Successful IPTs, 1995) According to DoDD 5000.2R, the Cost-Performance IPT must establish cost objectives

for each element of program life-cycle cost: RDT&E, production, operations and support, and disposal. Integrate and evaluate all cost-performance tradeoffs. Assess progress towards meeting the cost objectives at each developmental milestone with the use of quantifiable metrics. Implement incentives to encourage accomplishment of the cost goals. (DoD Guide to Successful IPTs, 1995)

b) Cost-Performance IPT Approach

Although Cost-Performance IPT activities continue throughout the life of a program, they focus on the principle that the best time to reduce life cycle costs is early in the acquisition cycle by shaping requirements and proposed design changes. (DoD Guide to Successful IPTs, 1995) The Cost-Performance IPT establishes cost goals through consideration of projected out-year resources, recent unit costs, historical cost analysis, mission effectiveness studies, cost-performance tradeoffs, and technology trends. (DoDD 5000.2R, 1996)

Once established the program manager uses the cost goals as a management tool. (Kaminski, 1995) For example, the program could structure Request for Proposals and contracts to provide incentives to industry to meet the CAIV cost goals. Source selection boards should base their decisions, in part, on a contractor's ability to meet the cost goals.

The contractor then allocates the overall cost goals to specific sub-components of the chosen weapon design. (Defense Acquisition Deskbook, 1997) The contractor allocates a cost target to each sub-component and uses a system engineering approach in designing the system to meet the cost goal.

Team members are empowered by program management to recommend performance and/or engineering and design changes as long as the threshold values in the Operational Requirements Document are satisfied. (DoDD 5000.2R, 1996) If the Operational Requirements Document threshold values require change, the program manager is responsible for bringing the change before approval authorities for decision.

c) Cost-Performance IPT Membership

The program manager chairs the Cost-Performance IPT, which includes representation from the user, OSD, and defense contractor communities. Specifically, under the direction of the program manager the Cost-Performance IPT establishes cost objectives and facilitates cost-performance tradeoffs through a continuous, interactive

Participants in the CAIV Process

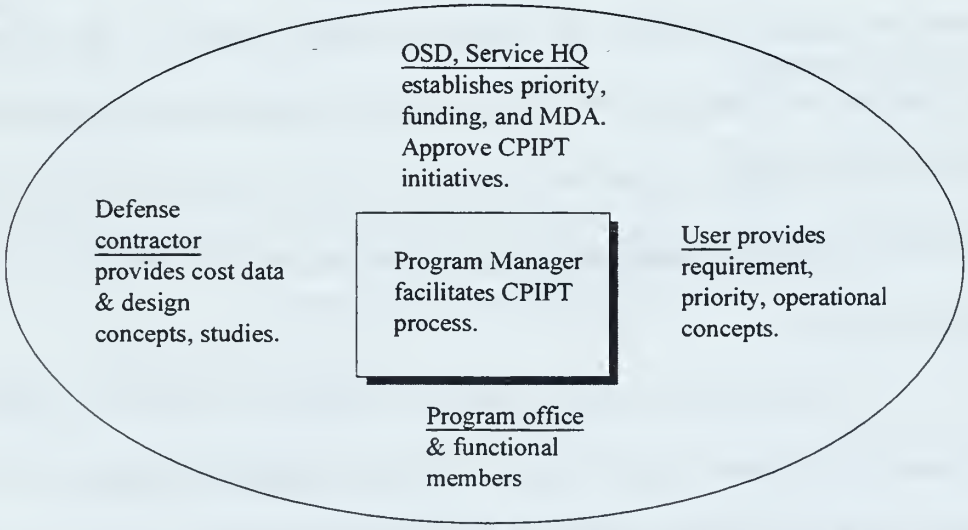


Figure 3-2

Source: Defense Systems Management College (1997)

process with team members depicted in Figure 3-2. (Defense Systems Management College, 1997) The activities of concept and design, operational requirements, funding, and program office migrate into one integrated team.

The program evaluation officer and other members of the OSD staff, service acquisition executive and service headquarters staff participate by determining funding availability, program priority, and programmatic direction. The contractor provides design concepts, cost data, and cost analysis necessary to conduct cost-performance tradeoffs. The military user provides requirements priority and input into the trades. Members from the program office provide functional representation and technical expertise.

d) Keys to an effective Cost-Performance IPT

The acquisition literature identifies keys to an effective Cost-Performance IPT. First, a strong working relationship between the program manager and the military user is essential to Cost-Performance IPT effectiveness. (Defense Systems Management College, 1997, p.14-6) In the absence of the military user the essence of CAIV—cost-performance tradeoffs—could not happen. The Cost-Performance IPT could not shape the operational requirement.

Second, "maximizing a Program Manager and contractor's flexibility to make cost-performance tradeoff tradeoffs without unnecessary higher-level permission is essential to achieving cost objectives". (DoDD 5000.2R, 1996) In other words, flexibility, teamwork, and empowered decision-making are essential elements to an effective Cost-Performance IPT. To aid the program manager's flexibility the number of

threshold requirements shall be limited, and they shall represent warfighter minimums. (DoDD 5000.2R, 1996)

F. SUMMARY

This chapter described CAIV in terms of its principles, objectives, cost reduction strategies, Cost-Performance IPT functions, and its approach to implementing CAIV. CAIV is operating in a DoD environment where participants' behaviors and incentives require change. CAIV is an acquisition reform effort that addresses the behaviors and incentives that lead to rising costs.

Dr. Gansler, current USD (A&T), wrote in 1980, "If DoD is ever going to reverse the downward trend in amounts of equipment procured without enormous budget increases, the only way to do it is to make cost a major criterion." (Gansler, 1980, p.278) Cost appears to be a major criterion in the work that takes place in the Cost-Performance IPT. The Cost-Performance IPT is a mechanism that attempts to control the user's behavior, and, therefore, costs.

IV. MANAGEMENT CONTROL SYSTEMS AND CAIV

A. OVERVIEW

In this chapter I provide the framework to view OSD CAIV policy in terms of a strategic management control system. I begin by defining the commercial industry approach to management control systems, identifying the elements of a control system, and discussing factors that can lead to the effective employment of a control system. Then in contrast to the commercial approach, I describe the DoD approach to management control systems, and identify the major difference between the two approaches. The differences are key when thinking about CAIV as a strategic control system.

B. MANAGEMENT CONTROL SYSTEM

1. What is a Management Control System?

Simons' defines management control systems as "the formal, information-based routines and procedures managers use to maintain or alter patterns in organizational activities." (Simons', 1995, p.5) Anthony states the purpose of a management control system is the implementation of strategy. "Management control is the process by which managers influence other members of the organization to implement the organization's strategy." (Anthony, 1988, p.10)

Euske uses Anthony's definition to emphasize that the function of management control is to facilitate the accomplishment of organizational goals through the implementation of identified strategies. (Euske, 1984, p.2) Merchant states that for

purposes of designing a management control system, it is useful to have strategies that are specific, detailed, and current.

> Formal strategic statements make it easier for upper management both to identify the feasible control alternatives and to implement them effectively. The controls can be targeted to the organization's critical strategic factors, such as developing new products, keeping costs down, or enhancing market share. (Merchant, 1998, p.4)

Simons' management control levers drive strategic change and renewal and address Merchant's concern about keeping strategy current. He introduces four levers of control, which provide a framework for the evolution and implementation of strategy.

> Strategic control is not achieved through new and unique systems but through belief systems, boundary systems, diagnostic control systems, and interactive control systems working in concert to control both the implementation of intended strategies and the formation of emergent strategies. (Simons, 1995, p.34)

Figure 4-1, and the following explanation, depicts Simons' framework of management control levers.

Four Levers of Management Control

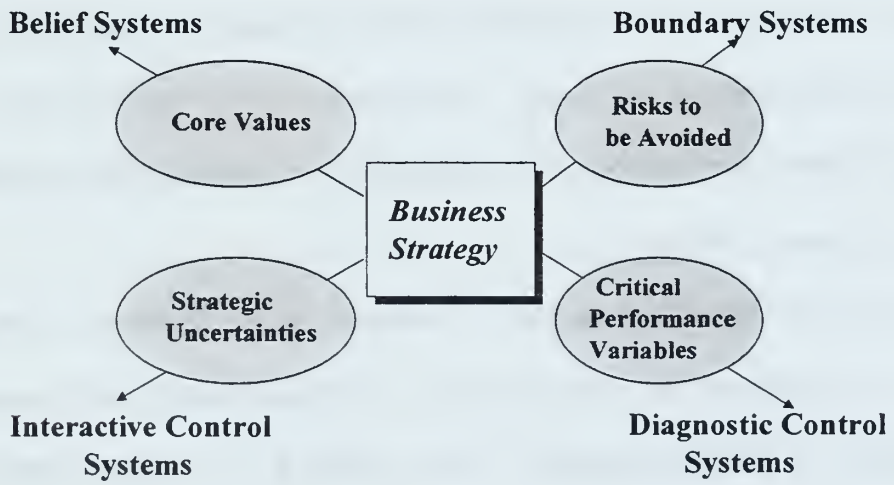


Figure 4-1

Source: Simons, Robert, Levers of Control, Harvard Business School Press, 1995, page 7.

1. A beliefs system is the explicit set of organizational definitions that senior managers communicate formally and reinforce systematically to provide basic values, purpose, and direction for the organization. Senior managers want subordinates to adopt the values and direction. (Simons, 1995, p.39)

2. Boundary systems delineate the acceptable domain of activity for organizational participants, and establish areas where risks are to be avoided." (Simons, 1995, p. 59)

3. Diagnostic control systems are designed to ensure predictable goal achievement. Three features distinguish traditional diagnostic controls systems, a) the ability to measure the outputs of a process, b) the existence of predetermined standards against which actual results will be measured, and c) the ability to correct deviations. (Simons, 1995, p.95)

4. Interactive control systems are the formal information systems that managers use to actively participate on a regular basis in decision activities of subordinates. (Simons, 1995, p.97) The control system focuses the entire organization on the area that managers choose.

Simons defines four characteristics of the interactive control system.

- Information generated by the system is an important and recurring agenda addressed by the highest levels of management.
- The interactive control system demands frequent and regular attention from operating managers at all levels of the organization.
- Data generated by the system are interpreted and discussed in face-to-face meetings of superiors, subordinates, and peers.
- The system is a catalyst for the continual challenge, and debate of underlying data, assumptions, and action plans. (Simons, 1995)

Through dialogue, debate, and learning new strategies emerge. (Simons, 1995,) A control system is interactive if it triggers revised action plans. (Simons, 1995) Figure 4-2 depicts Simons interactive management control model.

Simons'
Interactive Management Control System Model

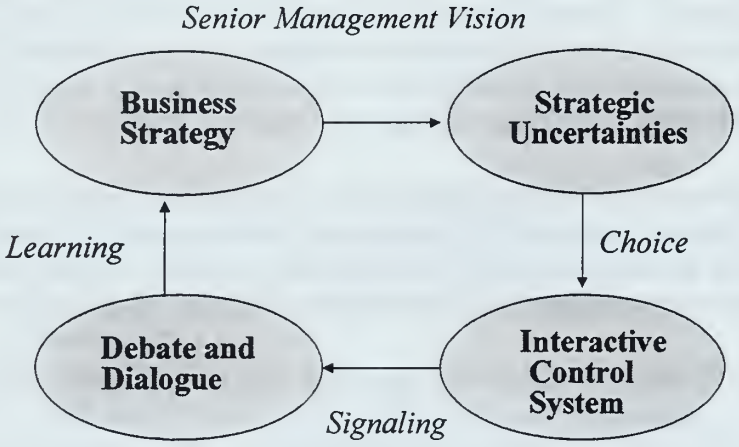


Figure 4-2

Source: Simons, Robert, Levers of Control, Harvard Business School Press, 1995, page 102.

Appendix A summarizes the "what," "why," "how," "when," and who," of the four levers of control managers use to control the evolution and implementation of strategy. Appendix A also includes a summary of the use of internal control systems, which is not among the systems Simons, or any of the previously mentioned authors, proposes that managers use to control the implementation of strategy.

2. Elements of a Management Control System

The previous section discussed management control in terms of implementing strategy. Once an organization has formulated its strategy, it requires a control system to implement strategy. What would a management control system look like? Table 4-1

identifies specific elements and activities of that make up a generic management control system.

Control Elements	Control Activities
Plan organizational goals	Goals (or objectives) state what is to be achieved and when results are to be accomplished. (Mintzberg, 1996, p.3)
Communicate goals and objectives	Management control requires coordination and communication among individuals because all parts of the organization must work together to achieve the goals and objectives. (Anthony, et.al.,1992, p.7)
Determine outputs and standards for assessment	Specific elements of performance are identified and incorporated into the control system, and are consistent with organizational goals and objectives. (Euske, 1984, p.3)
Detect information, activities, or behaviors	Components of the control system, such as a series of reports, or a management information system, which detect information for evaluation. (Euske, 1984, p.3)
Rewards, incentives, and sanctions	Rewards, incentives, and sanctions are attached to this component of the control system. (Euske, 1984, p.5)
Evaluate information about activities, or behaviors against standards	Managers make decisions as to whether differences in actual and standard performance is significant enough to warrant action. (Anthony, et al.,1992, p.7)
Initiate feedback to ensure organization stays on strategic course.	Information flows back up to upper management about progress in achieving intended strategies. (Simons, 1995, p.6)

Table 4-1, Generic Management Control System

A management control system that consists of plans, standards for assessments, evaluation, and feedback do not necessarily guarantee that an organization will achieve its goals. An organization still must answer the question of how to get managers and

subordinates motivated to move in the right direction and implement its strategy. The next section discusses these factors to effective management control.

3. Factors in Effective Management Control

Management control is meant to achieve objectives, focus on results, and is concerned with people who ultimately make an organization successful. (Euske, 1984, p.2) However, the effectiveness of any management control system depends on a number of factors. This section briefly discusses behaviors, incentives, and organizational structure, culture, and direction as factors that effective management control.

a) Behaviors

Euske states that possibly the most important aspect of management control is that it is concerned with people in organizations. (Euske, 1984, p.3) Anthony et al. (1992) notes that the management control process is primarily behavioral. The key to effective control is goal congruence, which matches the goals of managers, and their subordinates, with organizational goals. (Anthony et al., 1992, p.12) The control system must control behavior to positively influence the outcome of organizational strategy, and ensure organizational strategy stays on course.

Newman states that managerial control is effective only when it guides someone's behavior. The purpose is not concerned so much with measurements and reports, but changing behavior. (Newman, 1975, p.4) Newman's point is that the mere existence of a control system does not determine its effectiveness. Anthony (1988) notes that a control system is effective only if it changes behaviors in managers and subordinates, and they become congruent with organizational goals. An organization's

ability to achieve goal congruence is key to an effective control system and the implementation of business strategy.

b) Incentives

In addition to the reward structure, positive and negative incentives influence people in a way that furthers the goals of an organization. (Anthony, et al., 1992) Anthony et al. (1992) list a few incentives that are useful when examining DoD implementation of CAIV:

- Senior managers must signal to subordinate managers that the management control system is important
- Individuals are highly motivated when they receive feedback
- Motivation is weakest if the goals are too hard to obtain, or too easily obtainable
- Incentives provided by budgets, or cost goals, is strongest

c) Culture

Since management control is fundamentally behavioral, the organizational climate, or its culture, is another challenge to effective control. (Anthony, 1988, p.74) Is the culture congruent with the organizational goals? An organization's management control system may actually control more effectively, because its culture is a better fit with the organization's strategy. (Anthony, 1988, p. 75) The culture may or may not promote autonomy, teamwork, and empowerment. The culture may or may not be resistant to change. (Anthony, 1988, p. 76)

d) Structure

Mintzberg cites Andrew's model of corporate strategy, which highlight the importance of organizational structure in achieving results. An organization's structure must fit the task.

> An organizational structure appropriate for the efficient performance of the required tasks must be made effective by information systems and relationships permitting coordination of subdivided activities. (Mintzberg, 1996, p.49)

e) Direction

Finally, Merchant argues people may perform poorly, and not meet expectations, simply because management has not provided direction. A control system function involves informing employees how they can maximize their contributions and meet organizational objectives. (Merchant, 1998) As Anthony already noted, management control requires communication and coordination among all individuals in the organization. Managers must provide and communicate the organization's strategy.

How does the preceding description of management control systems differ from DoD use of control systems? The next section discusses Office of Management and Budget (OMB) implementing directives, DoD directives, and program office use of management controls.

C. MANAGEMENT CONTROL IN DOD

The use of management control in DoD begins from a broad federal government perspective of management control, then narrows its scope to a DoD perspective of management control, and finally to the use of management control in major defense acquisition programs.

The Federal Manager's Financial Integrity (FMFIA) Act of 1982, Chief Financial Officers (CFO) Act of 1990, and Office of Management and Budget (OMB) Circular A-123 dated 21 June 1995, establish the policy and framework for the use of management control in the federal government.

DoDD 5010.38 dated 26 August 1996 and DoD Instruction (DoDI) 5010.40 dated 28 August 1996 are the implementing directives for the use of management control.

1. Federal Definitions and Concepts

The FMFIA, CFO Act, and OMB A-123 provide the Federal perspective on management control. The FMFIA requires agency heads establish controls to ensure that obligations and costs comply with applicable law, assets are safeguarded against fraud, waste, loss, unauthorized use, or misappropriation, and revenues, and expenditures are accounted for and properly recorded. The FMFIA requires the agency head submit an evaluation report to Congress every year on the control systems in use and how they protect the integrity of federal programs. The FMFIA Act encompasses program, administrative, and operational areas as well as accounting and financial management.

The CFO Act requires the preparation and audit of financial statements of 24 federal agencies in order to improve control over an agency's financial activities. Since the audit of financial statements require a report on the internal controls and compliance with laws and regulations, the CFO Act should help federal agencies establish and evaluate management controls. (OMB Circular A-123, 1995)

OMB A-123 Management Accountability and Control was issued under the authority of FMFIA. It defines management controls as the organization, policies, and procedures used to ensure that programs achieve their intended results, resources are protected from fraud, waste, and mismanagement, laws and regulations are followed, and

reliable and timely information is obtained. The OMB circular further defines management controls as follows.

> Management controls, in the broadest sense, include the plan of organization, methods, and procedures adopted to ensure that its goals are met. Management controls include processes for planning, organizing, directing, and controlling program operations. A subset of management controls are the internal controls used to assure that there is prevention or timely detection of unauthorized acquisition, use, disposition of the entity's assets. (OMB Circular A-123, 1995)

2. DoD Definitions and Concepts

a) DoD Directive 5010.38, Management Control Program

DoDD 5010.38 is the implementing directive for the DoD management control program. The Under Secretary of Defense (Comptroller) (USD(C)) is the implementing agency for the CFO Act, FMFIA Act, and OMB A-123 requirements. The acts require submission of two compliance reports, the Statement of Assurance and Report on Material Weaknesses, which the USD(C) is responsible for submitting to Congress. DoDD 5010.38 defines effective management control policy as reasonable assurance that the following is accomplished:

- Obligations and costs comply with applicable law
- Assets are safeguarded for fraud, waste, unauthorized use, and misappropriation
- Revenues and expenditures are properly recorded and accounted for
- Programs and operating functions are carried out in accordance with applicable law
- The management control process emphasizes prevention of waste, fraud, mismanagement, and timely correction

DoDD 5010.38 expands the scope of DoD management control policy with the following statement. DoD organizations shall "address all significant operations and mission responsibilities and not limit evaluations to the financial management community." (DoDD 5010.38, 1996)

The directive requires the maintenance of system documentation for management control programs. System documentation includes policies, procedures, organizational charts, manuals, and flow charts to describe organizational structure, operating procedures, and administrative practices to communicate responsibility for accomplishing programs and activities.

b) DoD Instruction 5010.40, Management Control Program Procedures

DoDI 5010.40 implements policy, assigns responsibilities, and defines management control concepts and terms. It defines a control objective as a specific aim, goal, condition, or level of control established by a manager of an assessable unit, such as a program office. The instruction defines a control technique as any form of organizational procedure or document flow that the program manager relies upon to accomplish a control objective.

Of note, the update to DoDI 5010.40, August 1996, replaced the term internal management control with management control. Managers use controls, such as a system of reports, instructions, regulations, or procedures to carry out missions, operational objectives to ensure programs achieve their intended results. (DoDI 5010.40, 1996) Management controls are an integral part of the planning, budgeting, management, accounting, and auditing process and provide continual feedback. (DoDI 5010.40, 1996)

3. Management Control in DoD Major Defense Acquisition Programs

DoDD 5000.1 identifies two acquisitions documents as meeting Federal and DoD requirements for implementation of a management control program. The Acquisition Program Baseline (APB) contains control objectives for a program's important cost, performance, and schedule parameters. (DoDD 5000.1, 1996) The second document is the Defense Acquisition Executive Summary (DAES) report, which contains any deviations from a program's APB and stated exit criteria. (DoDD 5000.1, 1996) Both of these documents are used at the OSD level to monitor an acquisition program's goal accomplishment.

Below the OSD level, program managers generate another set of program control reports, and at still another level, defense contractors use their own management control system, and any control systems required by the government. The next section describes this hierarchy of program controls.

a) Control at the OSD Level

The APB formalizes an agreement between the program manager and OSD acquisition decision-makers by establishing an explicit set of desired outcomes. Drezner and Krop, 1997, p.1) The APB contains a set of measurable goals, which allow the OSD decision-maker, usually the Milestone Decision Authority, and the program manager, to track a program's progress against the goals.

The APB contains only the most important cost, performance, and schedule parameters. (DoDD 5000.1, 1996) Performance parameters designated as key performance parameters by the Joint Requirements Oversight Council are lifted from the user are Operational Requirements Document and included in the APB. (DoDD 5000.1,

1996) The program manager proposes schedule parameters to include milestone decision points, initial operating capability, and any other critical system events. Included in the APB are RDT&E costs, Average Unit Procurement Cost (AUPC), total quantity, and any other cost objective designated by the Milestone Decision Authority. If a program breaches any one parameter, the Milestone Decision Authority can reevaluate a program's design approach for continued development. (DoDD 5000.1, 1996)

The DAES is a status report prepared by the program office for OSD staff personnel. (DoDD 5000.1, 1996) It highlights potential and actual problems a program might experience before they become significant. Included in the DAES are a program assessment, current estimates, and deviations from the APB parameters, unit costs, and an assessment of the exit criteria. The program manager proposes exit criteria, which serve as gates that must be passed or demonstrated prior to entering the next phase of development or production. (DoDD 5000.1, 1996)

b) Control at the Program Office Level

Additionally, DoDD 5000.1 requires program office use of additional reports to monitor program progress. Some of the reports are independent of the program office's span of control. For example, the program office participates in the DoD budgeting process to ensure no disconnect exists between resources planned by the program office, and those that are programmed and allocated by the service chiefs.

Developmental Test & Evaluation (DT&E) reports, and Operational Test & Evaluation (OT&E) reports are independent of the program office, but used to monitor progress in performance parameter achievement. Independent cost estimates by the OSD

Cost Analysis Improvement Group (CAIG) are used to monitor progress in cost parameter achievement. (DoDD 5000.2R, 1996)

The program office uses of Cost/Schedule Control Systems Criteria (C/SCSC), or Earned Value Management Systems (EVMS) internally. C/SCSC is a set of standards for measuring the adequacy of a contractor's management control. (DoDD 5000.2R, 1996) It provides a framework, which consists of 32 criteria, to define work, schedule, and budget to the lowest levels of the contractor's organization. EVMS is the objective measurement of completed work and work in process for comparison with planned and actual values for the same work. As work is performed, it is earned on the same basis as it was planned, in dollars or other quantifiable units such as labor hours. (Abba, 1997, p.60)

Another internal program office activity is development of a Work Breakdown Structure (WBS). (DoDD 5000.2R, 1996) The program office, contractor, and systems engineering personnel define the weapon system, then sub-divide the system into subsystems or subcomponents (i.e. hardware, software, date, support, and services). The contractor uses the WBS to report cost, performance, and schedule variances against each of the identified subsystem components to the program office. (DoDD 5000.2R, 1996)

c) Control at the Contractor Level

An analysis of management control at the contractor level is beyond the scope of this thesis, but a contractor must internalize C/SCSC, EVMS, and WBS into its corporate management control systems in order to comply with government requirements. DoD requires other reports that deal with contract management reporting,

for example, Cost Performance Report, Contractor Cost Data Report, Cost/Schedule Status Report, and Contract Funds Status Report. (DoDD 5000.2R, March 1996) Additionally, items discussed earlier in the chapter, financial measures such as bonus plans, compensation plans, profit plans, and non-financial measures such as quality standards, training, team-building skills might also be a part of a contractor's management control system.

Figure 4-3 summarizes a hierarchy of management control reporting requirements at the OSD, program office, and defense contractor level.

Hierarchy of DoD Management Control Reporting

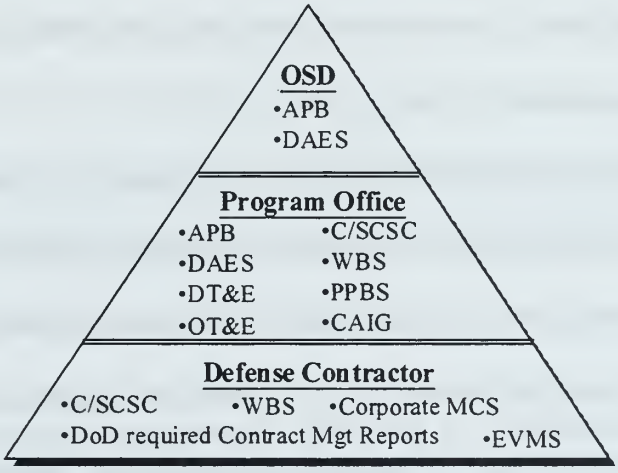


Figure 4-3

D. DIFFERENCES IN DOD & COMMERCIAL MANAGEMENT CONTROL

Fundamental differences exist between the commercial approach to management control systems and the DoD approach to management control systems. First, the DoD approach to management control appears to be narrowly focused on internal and financial control systems, whereas the commercial approach ties control systems to the

implementation of strategy. Despite USD(C) references to internal control systems as being a subset of management control, the preponderance of DoD literature is concerned with safeguarding assets, properly recording and accounting for revenues and expenditures, and prevention of fraud, waste, and mismanagement. Simons states the following about internal control systems.

> Internal control systems are not among levers used by managers to control strategy. They are, however, fundamental to ensuring the integrity of data used in all other control systems. (Simons, 1995, p.181)

Notably absent from the DoD approach to management control is its relationship to the implementation of strategy. For example, absent from DoD literature is any statement, such as the one cited by Anthony (1988) earlier in the chapter, linking strategy to the control system. The process of management control influences managers to implement the organization's strategy.

The lack of such a relationship could be a byproduct of the CFO Act and FMFIA Act, since the Acts emphasize the protection of public goods and services from fraud, waste, and mismanagement. Anthony (1988) implies other reasons.

> In many types of non-business organizations, particularly government, strategy formulation is especially unsystematic and difficult because leaders have differing opinions about what the entity's goals should be, and there is no rational way of resolving the differences. (Anthony, 1988, p.11)

Second, DoD uses the term management control program, whereas the commercial approach uses the term management control system. The difference in semantics is not a subtle one. From the preceding discussion a large number of management control "programs" exist in a hierarchy of DoD management control reporting. It does not appear that this large number of hierarchical control "programs," (e.g., contract reporting requirements, budgeting systems, and executive summary

reports) are linked together to form one management control system that facilitates the implementation of DoD acquisition strategy.

Andrew's concept of corporate strategy is a system. Formulation of strategy, which is deciding what to do, and implementation of strategy, which is achieving results, are tied together into one corporate system. (Mintzberg and Quinn, 1996, p.49) Simons uses the term "strategic control" to identify effective control systems with the "implementation of intended strategies and formation of emergent strategies". (Simons, 1995, p.156) The linkage between strategy and control is not explicitly stated in DoD instructions or guidance.

Third, it is not clear that the DoD management control program goes beyond abstraction and actually identifies a framework of control elements, activities, rewards and incentives, and how they are linked to strategy. In fact, an audit by the DoD Office of the Inspector General concluded that the DoD management control program was adversely impacted by the belief among many OSD and military department acquisition personnel that management control was a "paper exercise," which applied only to financial activities and property accountability. (DoDIG Report-96-028, p.7) Senior acquisition officials provided no guidance to Program Executive Officers and program managers on how to relate management control to the control structure for acquisition programs. (DoDIG Report-96-028, p.7)

The commercial approach to management control systems focus on such factors as behaviors, incentives, and organizational structure, culture, and direction that affect the management control system. The literature on management control spends a great deal of time on human behavior. The reward system, incentives, and culture are important

aspects to an organization's ability to achieve goal congruence. (e.g. Anthony 1988, Simons, 1996) Anthony (1988) notes that management control is behavioral and that effective control aligns personal goals with organizational goals. DoD directives and instructions lack this behavioral aspect in its approach to management control.

In summary, DoD approaches management control from a narrow financial aspect, whereas commercial industry approaches management control from a strategic perspective, which is the implementation of its strategy. A framework or strategic *system* exists in commercial industry that is concerned with behavioral patterns, rewards and incentives, organizational culture, structure, and strategic direction. In contrast to this system approach, no evidence could be found in the DoD *program* approach that integrated them into a single management control system. Table 4-2 lists the main points from the preceding discussion.

DoD Approach to Management Control	**Commercial Industry Approach to Management Control**
• Focus on Internal Controls • Management Control "Program" • Absence of a framework ✓ "paper exercise" ✓ hierarchy of programs, which must be implemented	• Focus on implementation of Strategy • Strategic Management Control "System" • Framework ✓ Tied to strategy ✓ Organizational structure ✓ Organizational behaviors and incentives ✓ Organizational culture

Table 4-2, DoD and Commercial Approaches to Management Control

E. SUMMARY

The commercial approach to management control is to integrate strategy, goals and objectives, and specific control elements, or components of the management control system, together into a single framework or *system* that is concerned with the implementation of strategy. The system integrates behavioral patterns, rewards and incentives, organizational culture, and organizational structure into a managerial framework.

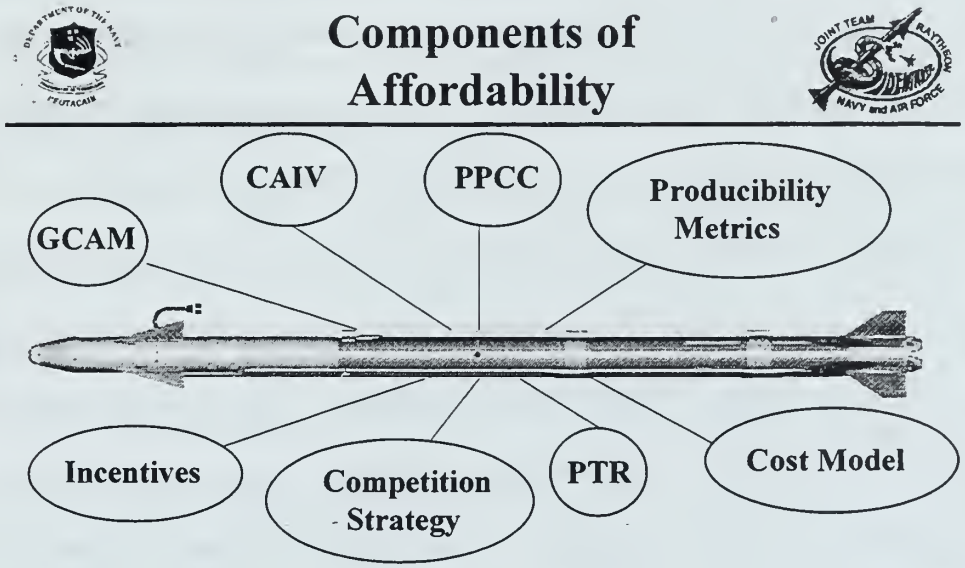
In contrast, the DoD approach to management control appears to focus on single programs concerned with safeguarding assets and prevention of fraud, waste, and abuse. Even in DoD acquisition programs, where there is less concern with safeguarding assets and prevention of fraud, waste, and abuse, little evidence exists that management control systems are concerned with the implementation of strategy. The interrelationships within the hierarchy of management control reporting do not appear to be well defined nor linked into one system responsible for the implementation of DoD acquisition strategy.

I propose that CAIV be viewed within the framework of a strategic management control system much like in commercial industry. After describing the implementation of CAIV into the AIM-9X program in Chapter V, Chapter VI discusses CAIV in this framework.

V. AIM-9X CASE STUDY

A. OVERVIEW

The chapter describes how the AIM-9X program office implemented the OSD CAIV policy and how it is presently utilized within the program office and the Raytheon AIM-9X team. The AIM-9X case study identifies a number of CAIV activities designed



Government Cost Account Manager (GCAM)
Procurement Price Commitment Curve (PPCC)
Price as a Technical Requirement (PTR)

Figure 5-1 Source: AIM-9X Program Office

to reduce AIM-9X costs in order to implement the DoD affordability strategy. The AIM-9X program puts cost on an equal footing with performance, and as Figure 5-1 illustrates, there are a number of program office and contractor activities to reduce costs.

The chapter divides the case study into four main sections: program background, organization, CAIV implementation, and cost savings. Central to the organization of this chapter is the OSD CAIV objectives discussed previously in Chapter III.

B. BACKGROUND

1. Program

The AIM-9X Sidewinder is currently in its E&MD stage of development. Raytheon Missile Systems Company, Tucson, Arizona, is the AIM-9X developer and manufacturer.

The AIM-9X program office awarded two eighteen-month Demonstration and Validation (DEM/VAL) contracts to Hughes Missile Systems Company and Raytheon Company in December 1994. (Longuemare, 1995) DEM/VAL was used to demonstrate the potential capabilities of the contractor's prototype missile guidance systems and to prepare preliminary designs for an all-up-round AIM-9X missile. (Longuemare, 1995)

In December 1996, the DoD Milestone Decision Authority approved the AIM-9X program to proceed into E&MD. (Kaminski, 1996) The program office awarded the E&MD contract to Hughes Missile Systems Company. After contract award, Hughes Missile Systems Company was bought by Raytheon Company and is now called Raytheon Missile Systems Company. The E&MD contract includes full-scale development, options for Low Rate Initial Production (LRIP) of lots 1-3, and a commitment curve for the next four Full Rate Production (FRP) lots.

Navy and Air Force requirement officers project a combined purchase of 10,000 AIM-9X Sidewinder missiles over the life of the program. (Navy Budget Exhibit, 1998) The program production schedule is depicted in Table 5-1.

Fiscal year	FY00	FY01	FY02	FY03	To complete	Total program
QTY	150	250	600	600	8400	10,000

Table 5-1, AIM-9X Production Schedule
Source: AIM-9X Single Acquisition Management Plan (1997)

LRIP is scheduled to begin in FY 2000. Full rate production (FRP) is scheduled to begin in FY 2003. Initial operational capability is expected in FY 2002.

2. Operational Requirements

a) Concept of Operations

U.S. Navy and Air Force fighter aircraft are armed with two types of air-to-air missiles: the radar guided Advanced Medium Range Air-to-Air Missile (AMRAAM), and the heat seeking, infrared-guided AIM-9 Sidewinder missile. If U.S. fighters must employ an air-to-air missile against threat aircraft at beyond-visual range, an AMRAAM missile is the weapon of choice.

If U.S. fighters are unable to employ an AMRAAM missile, and must continue to within-visual range of threat aircraft, a "dogfight" between aircraft will occur. The pilot will employ the heat seeking AIM-9 Sidewinder missile after obtaining favorable positional advantage against the threat aircraft. The AIM-9 Sidewinder also must exhibit "dogfight" capabilities to shoot down threat aircraft such as the ability to launch at high off boresight angles, reject infrared countermeasures, and maneuver under high G-forces.

b) Threat

In 1990 U.S. military planners discovered the Russian version of a visual-range, "dogfight" missile, the AA-11 Archer. This missile is more capable than the U.S.-built AIM-9M Sidewinder missile. (Dornheim, 1995, p.37) The AA-11 has better maneuverability, infrared countermeasures capability, and can launch at much greater off boresight angles than the AIM-9M Sidewinder. (Dornheim, 1995, p.38)

Navy and Air Force planners wrote the AIM-9X Operational Requirements Document in response to the AA-11 threat. (Dornheim, 1995, p.38) The program's objective is the development of a short-range air-to-air missile, which allows U.S. aircraft to regain air superiority in a visual "dogfight." (Dornheim, 1995, p.38)

With the concept of operations and threat as a backdrop, Navy and Air Force users identified the following five operational requirements as key performance parameters:

- Operations in day and night
- Capability to launch at high off boresight angles
- Capability to track through Infrared Countermeasures
- Interface with multiple U.S. fighter aircraft
- High Probability of Kill (AIM-9X SAMP, 1997)

Figure 5-2 helps illustrate the AIM-9X operational requirement.

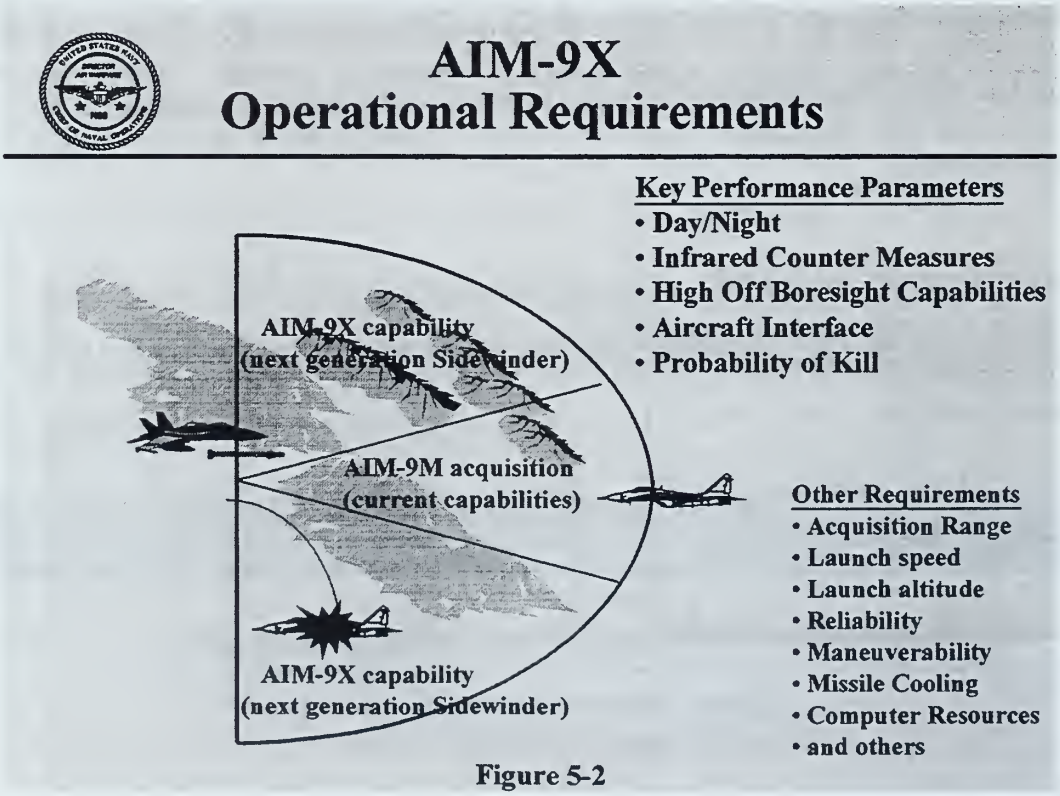


Figure 5-2

C. PROGRAM GOALS AND ORGANIZTION

1. AIM-9X Goals and Objectives

The program's goals and objectives are stated as exit criteria in the AIM-9X Acquisition Decision Memorandum. To enter LRIP the program must successfully meet the following exit criteria.

- Demonstrate Key Performance parameters and APB threshold reliability and maintainability requirements are achievable through a combination of development test and analysis.
- Analyze cost experience and price projections to confirm the ability to produce AIM-9X missiles at the price established in the LRIP contract.
- Demonstrate critical manufacturing processes using manufacturing capability, factory transition, and design stability metrics. (Kaminski, 1996)

Appendix B contains the full text of exit criteria for LRIP and FRP.

In addition to the goals and objectives, the program office and contractor have the following joint mission statement, which helps guide behavior of government and contractor personnel.

> Our contractor/government team will deliver to the warfighter an affordable AIM-9X weapon system that meets stated performance requirements within schedule. (Smith, 1998)

2. Program Office IPT Structure

An IPT structure dominates AIM-9X program management and organization. In the DEM/VAL stage, the program manager required Hughes and Raytheon to establish, implement, and document systems engineering processes to include the formation of IPTs. (DoDIG Report-97-064, p.5) The IPTs teamed government and contractor

representatives, to conduct formal and informal technical reviews, establish working groups, and exchange information, which expedited completion of the contracts. (DoDIG Report-97-064, p.5) Additionally, program management required the contractors to prepare monthly status reports evaluating the effectiveness of the cost, performance, and schedule of each IPT. (DoDIG Report-97-064, p.5)

In preparation for the E&MD phase, the program manager completely retooled the program office organization into an IPT structure as depicted in Figure 5-3. Major

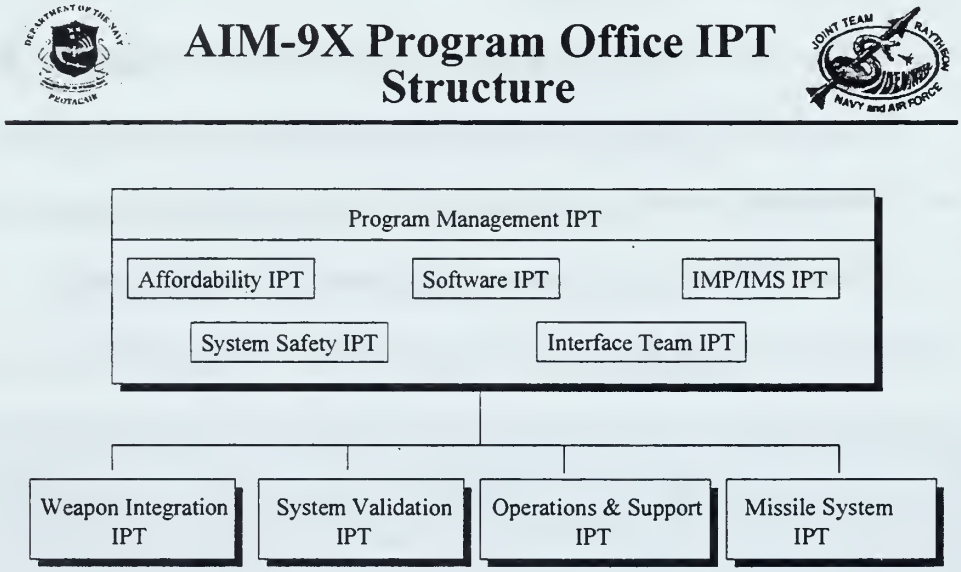


Figure 5-3 Source: AIM-9X Program Office

program management functions were replaced by the weapon integration, missile system, system validation, and operations and support IPTs, including a number of sub-IPTs, which exist within the program management IPT. The Affordability IPT is an example of a sub-IPT within the program management IPT. All IPTs include government and contractor personnel.

AIM-9X program management officials oversee IPT progress via daily contact with the IPTs, monthly cost and schedule reports, affordability and producibility metrics evaluation reports, design reviews, and program status reviews. (AIM-9X SAMP, 1997)

3. Cost-Performance IPT

In accordance with the *DoD Rules for Leading Successful IPTs* (1995), and as previously discussed in Chapter III, the AIM-9X Cost-Performance IPT plays an important role in the CAIV process. Key stakeholders on the Cost-Performance IPT are the OSD cost estimator, OSD program assessment representative, the OSD Overarching IPT coordinator, AIM-9X program manager and his functional representatives, and the Navy and Air Force users. (MacKenzie, 1998) In the earlier stages of program development the IPT felt compelled to frequently convene in order to determine the nature of cost-performance tradeoffs and cost reduction activities. The Cost-Performance IPT was instrumental in approving the contract incentive plan, award fee plan, producibility and affordability metrics, and cost-performance tradeoffs. (MacKenzie, 1998) As the program has matured in its current E&MD phase the Cost-Performance IPT is not compelled to convene as often. (MacKenzie, 1998) The team responsible for daily execution of cost reduction activity is the Affordability IPT.

4. Scope of the Affordability IPT

The scope of cost reduction activities by the Affordability IPT goes beyond recommending cost-performance tradeoffs. As discussed previously, DoD CAIV policy outlines several CAIV objectives, all of which are instrumental in holding down costs. The Affordability IPT mission statement is "to recommend to program management opportunities for reducing costs during all life cycle phases of the AIM-9X missile, from initial product development through disposal." (Goldstein, 1998) The participation of all

appropriate functional and management personnel whose expertise lies within the scope of the activities depicted in Figure 5-4, allows the IPT to provide program management with an integrated approach to affordability.

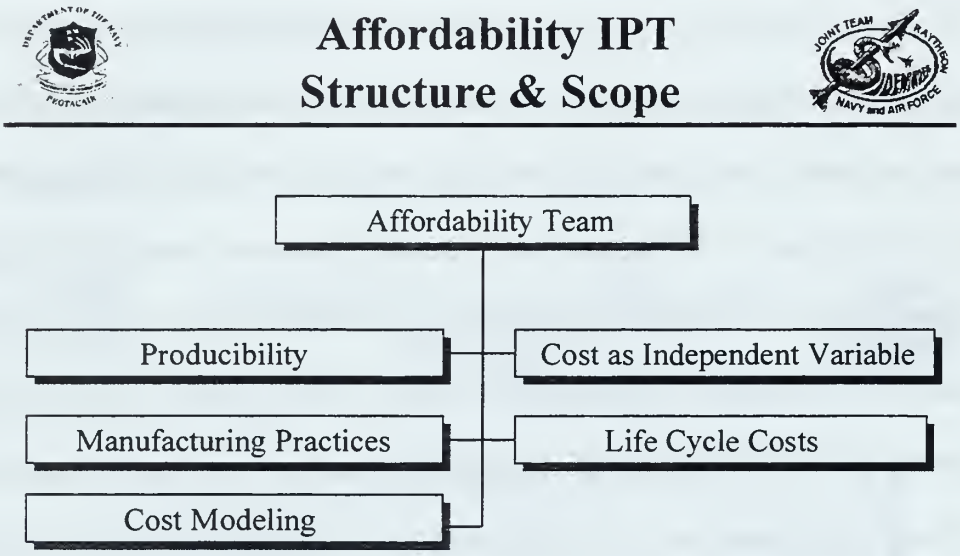


Figure 5-4 Source: AIM-9X Program Office

5. Working Environment

Although I cover in detail the implementation of CAIV in the next section, it is worth noting here the change in working environment for government and contractor personnel. Wade Smith, the Raytheon AIM-9X program manager, remarked about the change.

> What has really made the difference in the environment is that since E&MD award we have really created a teaming relationship between the government and contractor. We are working closely together and have a common mission statement, a common set of goals. We as a team sat down and explained what each of the goals meant to our personnel. The leadership from the government has helped facilitate a different paradigm, a different set of behaviors, such that we are always looking to the warfighter's best interests in the most cost effective way. (Smith, 1998)

D. IMPLEMENTATION OF CAIV

OSD outlined CAIV objectives in its 19 July 1995 and 04 December 1995 memorandums, which I covered in an earlier chapter. In addition to cost-performance tradeoffs, OSD identified aggressive cost goals, metrics, incentives, risk management, and reduction of operational and support costs as other CAIV objectives. The following section discusses how AIM-9X program management achieved each of these objectives.

1. Cost-Performance Tradeoff Process

Since the incorporation of CAIV into the AIM-9X program in December 1995, the cost-performance tradeoff process has evolved from a series of early round table discussions between the contractor, the program office, and the user into a formal Engineering Change Proposal (ECP) process. This section outlines the program's cost-performance tradeoff process and how it has evolved during program maturation.

a) User Participation

The user was involved early in the tradeoff process, even before OSD released its CAIV policy memorandum in July 1995. Prior to DEM/VAL, a Navy and Air Force Studies and Analysis group conducted an independent AIM-9X Cost and Operational Effectiveness Analysis (COEA). The purpose of the COEA was to consider a wide range of missile design options to meet user requirements, identify key performance parameters, and include the cost of each design option. (AIM-9X COEA, 1994) It indicated that air superiority could be achieved by upgrading the missile seekerhead and integrating a more maneuverable, nimble airframe with existing AIM-9M components. (AIM-9X COEA, 1994)

From the author's experience during a Joint Tactical Air-to-Air Missile Office Three-Star panel of Navy and Air Force requirement officers, and acquisition officials, determined from the COEA results, that the AIM-9X program should use rocket motors, warheads, and target detectors from the existing AIM-9M Sidewinder inventory. The cost of developing, testing, and producing these new components for the AIM-9X were avoided.[3]

During DEM/VAL, OSD initiated its implementation of CAIV and designated AIM-9X as a flagship program. After this designation, the program office tasked Raytheon and Hughes, the two DEM/VAL contractors, to conduct a review of the AS-5780 System Requirements Document.[4] The review enabled the contractor to identify those areas in the System Requirements Document it felt were cost drivers, and that the user might relax to achieve cost savings. The program office presented the results to Navy and Air Force users for approval. Afterwards, the results were presented to the Cost-Performance IPT, again with Navy and Air Force user participation, for final approval. (MacKenzie, 1998)

In both instances the user was willing to give up performance in exchange for cost savings. The user's decision resulted in Navy and Air Force controllers reducing

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[3] I distinguish between cost savings and cost avoidance, in that, cost savings is the reduction of already programmed fiscal resources from the DoD Future Years Defense Plan, whereas cost avoidance is the decision to forego any requirement to plan, program, and budget fiscal resources into the DoD Future Years Defense Plan.

[4] From the author's experience the AS-5780 is a program office document, which the acquisition community often refers to as the "spec," or military specification. The program manager includes in the AS-5780 all threshold and objective values from the user's Operational Requirements Document. However, program managers can, and often do, attach additional value to selected threshold requirements, and use them as a margin of error in design or testing. Since it is the AS-5780 on contract, defense contractors must design to the "spec" requirements, and not the Operational Requirements Document requirements, which shrinks opportunities for cost-performance tradeoffs.

budgeted resources from the AIM-9X program, and reprogramming those resources into other high priority weapon programs. The user approved eight changes to the Operational Requirements Document, which included, for example, changes to Built-in-Test reprogramming time, software language requirements, missile launch timeline sequence, and missile cool down time. (Gaddis, 1996) The amount of cost savings is discussed later in the chapter.

As stated previously, the AIM-9X program is currently in its E&MD phase with one contractor. Again, the nature of the CAIV tradeoff process has changed with program maturation. The range of options for cost-performance tradeoffs is narrower in the E&MD phase. (MacKenzie, 1998) The contractor is now building end items, and the occurrence of technical problems can negatively impact system performance and cost. If a problem does occur, the user must decide how important the performance requirement is, and if it warrants an increase in budgeted resources to fix the problem. The AIM-9X program manager commented on the changing nature of CAIV tradeoffs in the E&MD phase.

> Now that we have one contractor, CAIV takes on a different face, almost more of a cost avoidance face perhaps, than cost savings. If we run into a technical problem, which may impact the performance of the system, the user must be willing to compromise on that requirement or ask us to fix it. But that technical fix is going to cost more in development and production. CAIV then, takes on an almost negative connotation – I'm taking away performance to maintain cost, rather than taking away performance to gain savings. (MacKenzie, 1998)

b) Affordability IPT Cost-Performance Tradeoff Process

The Affordability IPT has formally incorporated the CAIV trade-off process as part of its daily functions. Major Bruce Goldstein, USAF, the Affordability

IPT lead, explains how the program implements CAIV in two ways. The IPT "provides a focus and a forum." (Goldstien, 1998)

> Management on both sides (government and contractor) must focus on looking at tradeoffs. The key is to have all your folks think it is okay to recommend performance changes if there is an associated reduction in production costs. That is a big change in the environment. Any cost reduction idea will be considered in order to meet the cost goal. (Goldstien, 1998)

The Affordability IPT provides the forum for its team members to recommend and initiate cost-performance tradeoffs by the incorporation of a new CAIV ECP category. Major Goldstein explained the new ECP category.

> The new category of ECP changes are now incorporated into Raytheon's integration plan. It brings the process to the top level of management. People are looking at engineering changes that they consider cost-performance tradeoffs as technical change. (Goldstien, 1998)

As depicted in Figure 5-5 the CAIV ECP process begins with an IPT team member proposal, which detail system performance, contract, and life cycle cost impacts. After a Program Analysis Team reviews and approves the change, it is then forwarded to the AIM-9X program office and its Management IPT. After the Management IPT reviews and approves the CAIV proposal, it is presented to the user and the Cost-Performance IPT. Once approved by the Cost-Performance IPT, the user makes the required changes to the Operational Requirements Document. User coordination and concurrence is required for every CAIV ECP proposal.

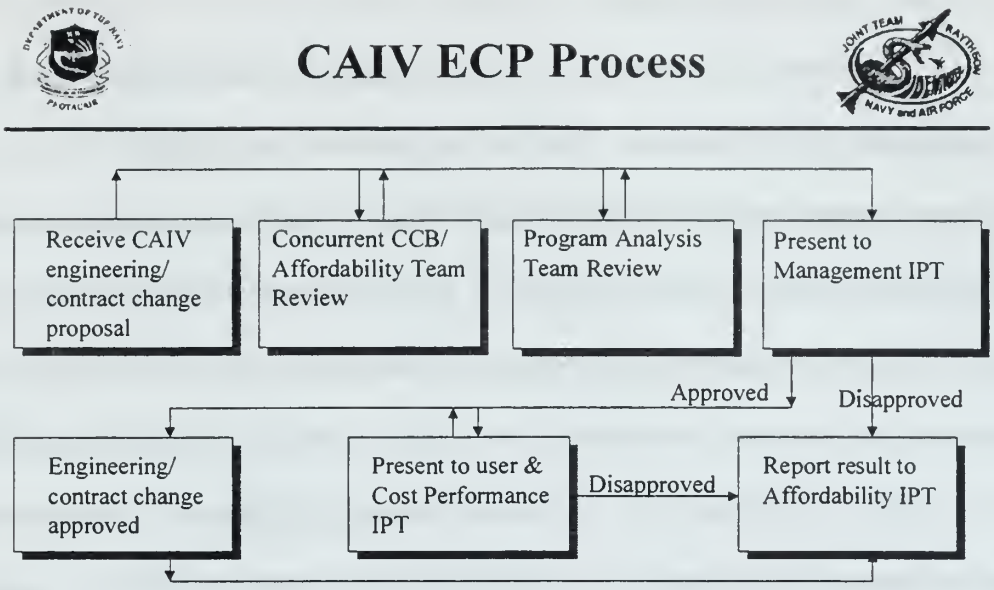

Figure 5-5 Source: AIM-9X Program Office

At the July 14, 1998 CAIV Flagship Update Working Group, Major Goldstein briefed two success stories using the process just described. The first success involved reduced production costs of aerodynamic missile surfaces. The IPT recommended to the user relaxing the operational requirement for kinematic range in certain areas of the maneuvering envelope. The cost-performance tradeoff allowed the contractor design team to increase the leading edge thickness to fixed and movable control surfaces, which saved the program $800 in production costs per missile, and $8 million in total program production costs.

The second success involved avoiding the cost of developing, testing, and integrating new guidance and control system software to meet a user requirement to launch the missile in accordance with a specified timeline after trigger squeeze. The user, again, was able to relax the timeline requirement, which allowed the contractor design team to avoid significant costs.

c) Trade Space

Chapter III discussed the cost-performance tradeoff process as one of the more important CAIV objectives. The user's Operational Requirements Document lists performance parameters in terms of thresholds, which is a minimum acceptable value that must be met to satisfy a mission objective. The Operational Requirements Document also lists an objective value for each parameter, which represents a beneficial increase in performance and mission capability. Trade space exists between the threshold and objective values. Additionally, the user categorizes each performance parameter as either a Key Performance Parameter or non-Key Performance Parameter (KPP). Whether or not trade space exists below threshold values, in particular, below threshold values designated for KPPs is a matter of conjecture and debate. This issue is discussed in more detail in Chapter VII.

During pre-DEM/VAL, the number of available missile design options considered in the COEA analysis determined the definition of trade space. (MacKenzie, 1998) From the available design options, the COEA determined the most cost-effective solution in meeting the user's requirement for a next-generation AIM-9 Sidewinder. The COEA also determined the user's threshold and objectives values for each performance requirement (KPPs and non-KPPs), that are contained in the Operational Requirements Document.

During DEM/VAL, the program manager placed a significant restriction on the contractor's review of cost drivers in System Requirements Document. The program manager considered those operational requirements, which the user designated as KPPs, as off limits in the review process. (AIM-9X CAIV plan, 1997) The contractor

could review all non-KPPs for possible relaxation to achieve cost savings. The restriction was a defacto definition of trade space.

From the author's experience, it was a decision strongly supported by the Navy and Air Force requirement action officers. From a user perspective, the KPPs are the essence of the AIM-9X modification program. The KPPs are required to defeat the AA-11 threat, and are the sole reason the program existed in the first place. From the author's experience, relaxation of KPP threshold values was viewed as a threat to program survivability in the DoD budget process.

In the program's current E&MD phase, another perspective emerges on trade space. The missile will ultimately undergo an independent Operational Test & Evaluation (OT&E). (MacKenzie, 1998)

> Threshold plus some margin is desired to pass OT&E, because of the statistical uncertainty surrounding the threshold value. You could fall a little bit short or a little over depending on the sampling technique. (MacKenzie, 1998)

It appears the effect of increased margin is to limit trade space between the threshold value and the objective value, but at the same time it decreases risk to the program manager that his weapon might fail Test & Evaluation.

Figure 5-6 summarizes the main points regarding the cost-performance tradeoff process from this section.

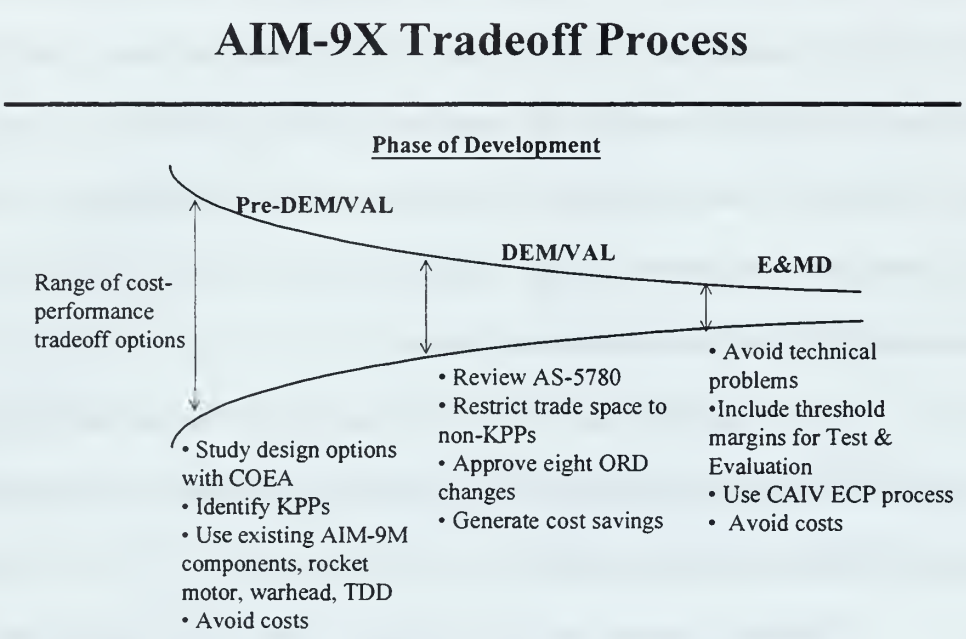

Figure 5-6

d) Setting Aggressive Cost Objectives

This section describes the process by which the program office and contractor established aggressive cost objectives. Since production costs traditionally account for 60-70 percent of total life cycle costs for air-to-air missiles, the AIM-9X program uses missile Average Unit Procurement Cost (AUPC) as its cost objective. (MacKenzie, 1998) The government and contractor management team spends a large amount of time focused on meeting the AUPC cost target, which is set forth in the contract. (MacKenzie, 1998) This section describes how the contractor manages its AUPC cost target, and the linkage between AUPC management and the use of cost models.

e) AUPC

During DEM/VAL, the contractors met quarterly with the program office for the purpose of establishing cost targets for AIM-9X production. Both contractors proposed to the program office that an AUPC goal, defined as the cost of the 5000th production unit, be established as the cost target, and made part of the E&MD/LRIP contract language. The AUPC cost target became the contract cost targets for award fee computations. (MacKenzie, 1998)

The contractors took a systems engineering approach to establishing cost targets in that cost estimators, production engineers, manufacturing engineers, systems engineers, business and financial managers, and program management participated in the quarterly meetings. (MacKenzie, 1998) Afterwards, both DEM/VAL contractors included their AUPC cost target, and individual cost targets for each of the first three LRIP production lots in their contract proposal. (MacKenzie, 1998)

f) AUPC Cost Management

Once the government and contractor signed an agreement on the AUPC, Raytheon developed a cost management system, which allowed the AUPC cost target to flow down to lower levels of management. (Smith, 1998) Figure 5-7 depicts how the cost target flows down to separate work activities.

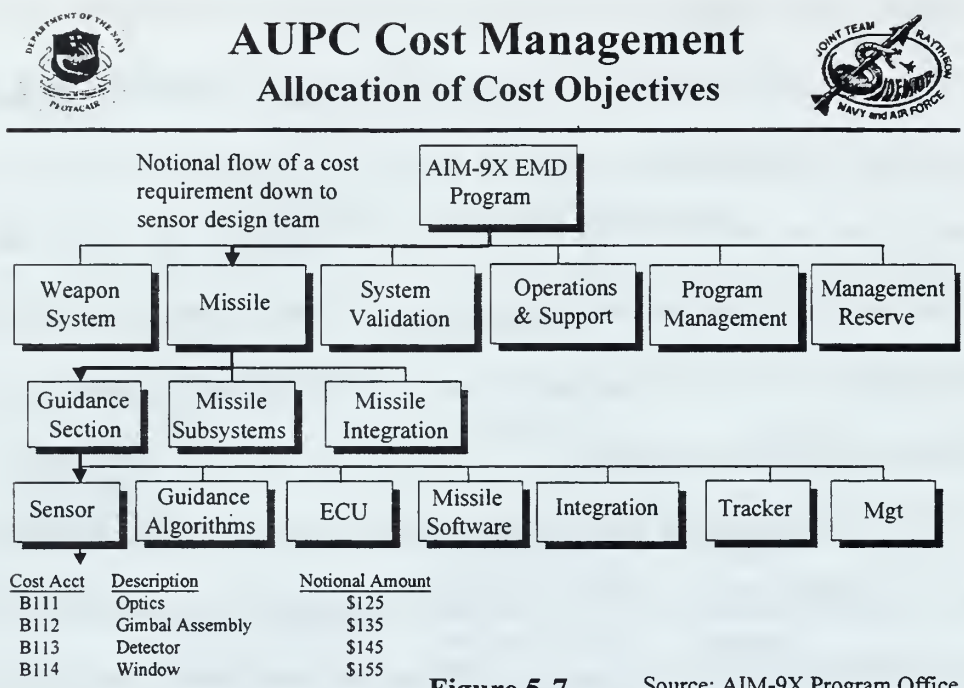

Figure 5-7 Source: AIM-9X Program Office

The Raytheon AIM-9X program manager, and chief engineer, assigns technical requirements, as well as a cost requirement, to each separate work activity, or design team. (Smith, 1998) Each design team knows what upper management is expecting from them in terms of performance and cost. Management assigns ownership of a performance requirement and a cost requirement to each design team. Wade Smith, Raytheon AIM-9X program manager, explains further how this cost management strategy works in practice.

> At each Preliminary Design Review and Critical Design Review, each team has to brief their design, but they also have to talk about producibility, manufacturing processes – are these processes in hand or do they have to be invented? - and what is their estimate of the cost. If they couldn't justify their cost or performance they had to go back and do more work. Because of this very, very disciplined focus on not only performance, but also cost, we have great assurance what this product is going to cost. (Smith, 1998)

Besides the cost management advantages of an AUPC breakdown, Wade Smith also pointed out that each team can identify CAIV opportunities as it is "wrestling" with its performance and cost requirements. If a team does have a performance problem, which affects schedule or other design decisions, with the respective cost implications, a CAIV opportunity exists to modify the requirement. (Smith, 1998)

> Then we can go back to our government team members and say, understand the warfighter needs this, but here are the cost implications of doing that. Do we really need that requirement or can we modify it a little? So by flowing down the requirement and cost to each team, that's where we raise CAIV issues. So I think that CAIV issues are an outgrowth of having cost be considered the same as performance at the design level. (Smith, 1998)

g) Use of Cost Model

The Raytheon has integrated its cost model down to all levels of the contractor development team. Management empowers each design team to take ownership of their cost requirement, and to use the model to study the cost implications of their design decisions. (Smith, 1998) As a design team studies different design approaches to achieving their performance requirement, they can model the cost implications of each approach. It encourages "what if" analysis and ensures real time production cost estimates early in the design process. (Goldstien, 1998) Cost modeling is a design requirement instead of a financial reporting tool.

> In the past the designers gave the end product to the cost estimator. Now each design team owns its share of the cost model and is aware of the cost goals. (Goldstien, 1998)

Wade Smith stated that Raytheon's cost modeling approach forces the design teams to consider alternative design options, for example, manufacturing processes, parts, suppliers, and materials. Raytheon management now holds its teams accountable and responsible for meeting their AUPC cost target. (Smith, 1998) Management has given ownership of the cost model to each design team, and their use of the models early in the design process is a key factor in meeting cost goals. (Smith, 1998)

Major Goldstein described the "philosophical change in the approach to design between Price as a Technical Requirement and Design to Cost." (Goldstien, 1998) Formerly, cost reduction efforts began after product design under the Design to Cost approach, whereas cost goals for each subsystem are set from the beginning of design work under the Price as a Technical Requirement approach. Since each engineer and designer has access and input into production cost modeling tools, they are expected to meet their cost goal. It is now considered a technical requirement. The cost goal is a result of an integrated government-contractor team analysis. (Goldstien, 1998) The difference between Price as a Technical Requirement and Design to Cost is summarized in Figure 5-8.

Raytheon trained key government personnel to use its cost model in order to achieve consistency in cost estimates. The AIM-9X program office assigns a government cost account manager for each Raytheon cost account manager to facilitate communication on cost issues, and provide a "bottom to top" analysis of contractor progress using the same tools. (Goldstien, 1998)

	Design to Cost	Price as a Technical Requirement
Owner	Managers, Bean Counters	IPT
How Set	Fiat, political expediency	Resulting from integrated team analysis
Who Sets	Govt	Ktr-Govt team
Penalties	None	Consideration/Fee
Reqmt Trades	No	Yes

Figure 5-8 Source: AIM-9X Program Office

The cost model has evolved during program maturation, although at a more rapid pace than usual because of the focus on costs shown by the AIM-9X program office early in the program. (Smith, 1998) Prior to DEM/VAL, Hughes did not have a cost model for the AIM-9X Sidewinder. Estimates of costs were generated by rules of thumb, analogy to other processes and programs, and crude assessments. (Smith, 1998) During DEM/VAL development of a detailed cost model became a high contractor priority because of the intense government interest in affordability. (Smith, 1998) The AIM-9X Milestone IV/I Acquisition Decision Memorandum specifically directed the use of contractor cost models to improve cost-performance tradeoff methodologies. Development and deployment of the cost model down to the lower levels of design responsibility became essential. (Smith, 1998)

> We wanted to make sure all the teams behaved in the same way. So we put out program instructions, briefings, meetings, and told people these are the rules to live by. Mainly, cost is an integral part of the design process. (Smith, 1998)

The cost model currently in use by Raytheon is essential to CAIV, because "a detailed cost model is required to make cost-performance tradeoffs." (Smith, 1998) It is a way to get engineers to "think CAIV." (Smith, 1998) The Affordability IPT meets quarterly to refine the cost model. The model receives data from negotiated subcontracts and vendor agreements, data from updated production floor metrics, and data from more current overhead rates. The IPT then uses the updated cost model to update the AUPC cost target, update individual production lot cost targets, and examine cost-performance tradeoffs. (Smith, 1998)

Just as the use of a detailed cost model is linked to meeting the AUPC cost target, producibility metrics are also a key determinant in meeting the AUPC cost target. The AIM-9X Acquisition Decision Memorandum also required development the development of quantifiable producibility metrics, which is covered in the next section.

2. Metrics

The AIM-9X Statement of Work states that the objectives of the E&MD phase of development is to enter into production with a stable design, gain a high confidence that production processes work at maximum rate conditions, and achieve throughputs and yields to meet the AUPC cost target. Four producibility metrics—manufacturing

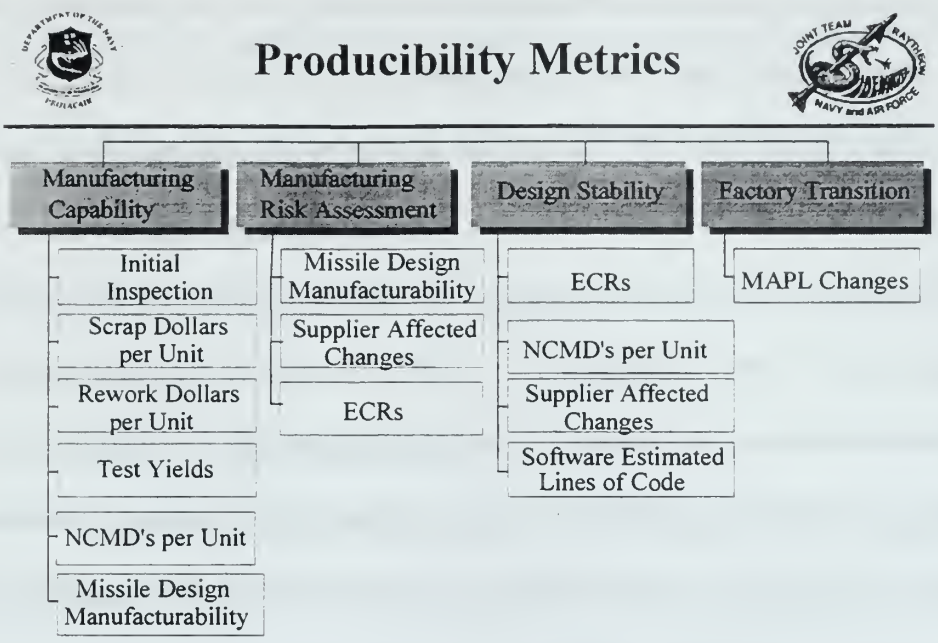

Figure 5-9 Source: AIM-9X Program Office

capability, manufacturing risk assessment, design stability, factory transition—are used to evaluate, track, and report progress towards meeting these objectives (Figure 5-9)[5]

The AIM-9X Statement of Work defines each of the producibility metrics. The contractor reports on manufacturing capability, which certifies AUPC, production rate, and product design requirements can be met. Manufacturing risk assessment is the evaluation of transition from development to production and the risks associated with the transition. Design stability indicates design maturity. Factory transition measures the progress in developing full rate production facilities. The quantifiable producibility metrics are monitored with monthly program management and operations process reviews. Factory level controls are monitored daily. Major Goldstein explained how producibility metrics are flexible and evolves with the program.

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[5] In fact, producibility metrics are so important to the program, they are included in the AIM-9X Acquisition Decision Memorandum as exit criteria or gates. The program office must successfully demonstrate achievement of the exit criteria prior to passing into the production phase.

> We continually look at the metrics for validity. Are they still valid? Do we need to measure them any more? Are we getting valid data and do we need to change them? (Goldstien, 1998)

The Affordability IPT has created another metric designed to drive down the average unit cost (AUC) for the first three production lots. Whereas AUPC is defined as the cost of the 5000th unit and is part of the E&MD contract, AUC is defined as the average cost of one production lot. The Affordability IPT established a joint government-contractor management goal of lowering the "T1" price, which is the average cost of the first production lot, by an additional 10 percent. (Goldstien, 1998) Although the goal is not a contract item, it provides the team another metric to measure program success. (Goldstien, 1998)

3. Incentives

The incentive to participate in the implementation of CAIV is different for the defense contractor, the government program office, and the user. This section explains the difference in incentives between the three groups.

a) Contractor Incentives

The program office used several methods to provide contractor incentives to reduce costs. First, in DEM/VAL the incentive to aggressively set lower cost goals was clearly the competition between Hughes and Raytheon to win the E&MD contract. (AIM-9X CAIV plan, 1997)

Second, the cost plus incentive/award fee contract structure offers significant incentives to Raytheon. It allows the program office to financially reward Raytheon if they can meet the producibility and affordability criteria for its product, while meeting performance requirements. (Goldstien, 1998) The contractor can receive

an award fee of as much as 12 percent of the E&MD contract target cost, if they meet program management criteria in the following areas:

- Program management
- Systems Engineering
- Technical performance
- Producibility
- Reliability (MacKenzie, 1998)

The contract also includes options for the first three LRIP production lots, which the program office may or may not choose to exercise depending on contractor performance. The options are fixed price incentive fee, with a 0/100 share ratio. (AIM-9X SAMP, 1998) This allows Raytheon to keep 100 percent of the savings if they fall below the contracted prices set for LRIP lots 1-3. Lower production prices yields larger profits for the contractor.

Third, a contractor-established outyear commitment curve, called a Procurement Price Commitment Curve (PPCC) for full rate production lots 4-7 (see Figure 5-10), provides an incentive for Raytheon to continue its cost reduction efforts. (MacKenzie, 1998) The PPCC represents the contractor's estimate for the average unit cost of the lots to be produced. Although the program office has not yet identified share ratios for lots 4-7, as long as Raytheon prices come in below the PPCC, chances are they will continue to produce AIM-9X with a sole source government contract. (MacKenzie, 1998)

Lastly, during source selection for E&MD the program office provided incentives to the contractor to reduce life cycle costs. Traditionally, programs have

treated development and production costs as more important than life cycle costs. (MacKenzie, 1998) During E&MD source selection, the program weighted life cycle costs as equally important as the E&MD and LRIP contract costs. (AIM-9X CAIV plan, 1997)

Figure 5-10 list positive contractor incentives in region A below the PPCC, which include sole source production, contractor configuration control, a government waiver of cost and pricing data, and development of a contractor missile maintenance depot. Contractor disincentives listed in region B above the PPCC include a competitive alternative, government configuration control, and financial penalties. During FRP of lots four and beyond, the program office envisions value-engineering incentives as a method to keep production costs below the PPCC.

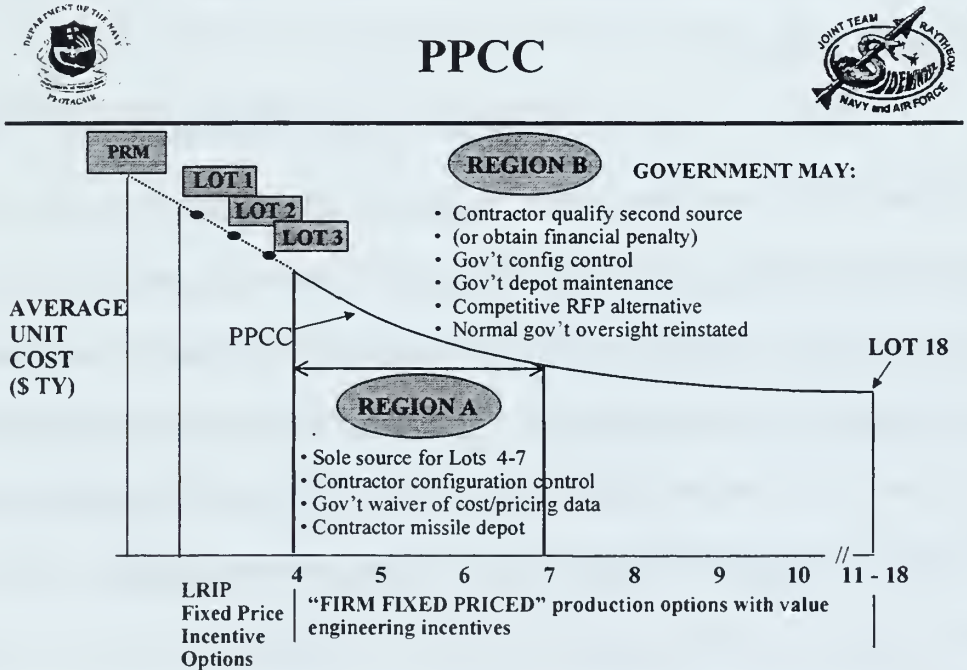

Figure 5-10 Source: AIM-9X Program Office

b) Government Program Management Incentives

Program management incentives to participate in CAIV are from three levels. From an external level, USD(A&T) directed all "Flagship" acquisition programs to implement CAIV. DoDD 5000.1 now directs all Acquisition Category I programs to implement CAIV. DON direction now includes the implementation of CAIV into Acquisition Category II programs as well.[6]

At a program office level, the incentive to participate in CAIV comes from its contribution to greater program stability and less uncertainty about funding. CAIV has helped "prevent requirements creep" from occurring in the AIM-9X program, which has led to a stable design process. (MacKenzie, 1998) From the program manager's perspective,

> Requirements creep comes from the traditional users, OT&E community, and contractor. Since the program has already turned money back in to its Navy and Air Force resource sponsors, it makes it hard for users, or the OT&E community, to add (additional) requirements into the missile design. I know exactly what I have money for and what I'm on contract to do. And I'm a much more stable player in the budget process. (MacKenzie, 1998)

The program has experienced minimal destabilizing pressures to stretch out its development schedule, which leads to higher life cycle costs, nor has it experienced any significant pressure to incur a budget cut, which would lead to a longer development schedule, and increased costs. (MacKenzie, 1998)

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[6] DoDD 5000.2R (1996) classifies a program as Acquisition Category I if RDT&E expenditures exceed $355 million (FY1996 dollars) or procurement exceed $2.135 billion (FY1996 dollars). A program is classified as Acquisition Category II if RDT&E exceed $140 million (FY1996 dollars), or procurement exceed $645 million (FY1996 dollars), but less than Acquisition Category I totals.

Additionally, since contractor profit is no longer a percentage of revenue, but based on a 0/100 share ratio of lowered production costs, the contractor does not have an incentive to add "bells and whistles" to the product. In the past, the contractor could use requirements creep to drive up revenue and profit, then convince the user to pay for it. (MacKenzie, 1998)

From the point of view of the program manager CAIV does increase risk in at least one area.

> Incentives for the contractor are easy because there are many ways to influence a contractor's bottom line or his profit. Incentives for the government side is a little harder to define because CAIV by its very nature attempts to streamline the process and cut out extra time. But the acquisition community views extra time as risk mitigation. You know technical difficulties will occur and you'll have to work through them. If you cut yourself short, then go over schedule, the program manager could look bad. (MacKenzie, 1998)

The AIM-9X program manager continues with specific comments about individual incentives during the CAIV process.

> The incentive for a program manager is to look good by building in schedule and cost reserve so he can work through the difficulties. It could be hard to look good when you cut yourself to the quick during the CAIV process. My budget is realistic, unless I have a problem. (MacKenzie, 1998)

The program manager is referring to promotions, peer esteem, and professional pride as incentives to actively participate in the CAIV process.

c) User Incentives

User incentives to identify cost-performance trades are hard to define. (Stutz, 1998) Commander Otto Stutz, the Navy's air-to-air missile requirements officer, made the following comments. In all the cost-performance trades to date, the program

office or contractor was the one that recommended cost-performance tradeoffs to the user. From the author's experience, the user has never voluntarily recommended cost-performance tradeoffs.

> We really aren't driving the CAIV train, but we do own the requirement. If an objective presentation of a CAIV opportunity is presented to us, and we can save money, then it only makes sense to do it. But we don't know about any cost-performance tradeoff opportunities unless the contractor brings it to us. (Stutz, 1998)

Another concern expressed by the user was the program office's fixed price incentive options for the contractor in the first three LRIP lots. The fixed price incentive options complicate the user's incentive to actively participate in the CAIV process. (Stutz, 1998) Since Raytheon keeps all savings below LRIP contracted prices, any cost-performance tradeoff benefits the contractor in terms of increased profit. In the short run, the user does not receive any benefits from the cost. (Stutz, 1998) However, in the long run, when the program manager and contractor negotiate contract prices for production lots 4-7, the user should see lower prices based upon actual price data from earlier production lots. (Stutz, 1998) The user can then decide whether to use the cost savings elsewhere in the DoD Future Years Defense Plan, or increase AIM-9X quantity. (Stutz, 1998)

4. Risk Management

During DEM/VAL the program office managed performance, schedule, and cost risk through risk management plans submitted by Hughes and Raytheon as part of the DEM/VAL contracts. A DoD Inspector General audit report stated that the AIM-9X risk management plans identified assessed, mitigated, and initiated systems to effectively manage performance, schedule, and cost risk. (DoDIG Report 97-064, p. 2) In E&MD,

the program manager has assigned the AIM-9X program office and contractor IPTs joint responsibility for implementing the risk management program. (AIM-9X SAMP, 1998)

User participation in selecting existing AIM-9M Sidewinder components for use in the AIM-9X modification program also reduced program risk. The decision reduced performance, schedule, and cost risk, and avoided the cost of developing new components.

Finally, GAO observe that program managers can reduce technological and performance risks if they select mature technologies. A GAO report, dated March 1998, states the following about AIM-9X program risk.

> Even though it is still too early to predict outcomes on the AIM-9X missile...their prospects appear promising because they have chosen mostly proven technology from existing programs to achieve performance requirements. (GAO-T/NSAID-98-123, p.9)

E. COST SAVINGS

Table 5-2 outlines current RDT&E and procurement estimates (FY97 dollars) required to complete the AIM-9X program.[7] Reductions in RDT&E in FY96 and FY97, and reductions in weapon procurement resources in FY96 are attributable to the implementation of CAIV in the AIM-9X program. The combined effects of the producibility metrics program, competition, PPCC, and adjustments in E&MD contract costs all contributed to the savings. (MacKenzie, 1998)

The program RDT&E cost estimates represent real savings in that Navy and Air Force Comptrollers reduced the AIM-9X FY96 President's Budget request by $116

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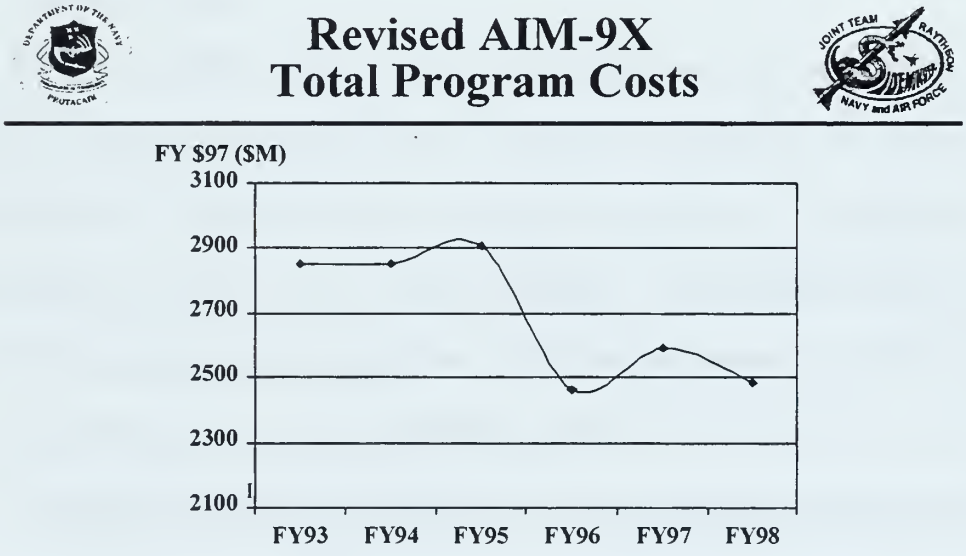
[7] Program cost estimates are derived from the AIM-9X Program Office December 1993 Life Cycle Cost estimate, the December 1994 Milestone IV/I Acquisition Program Baseline, and the September 1998 Defense Acquisition Executive Summary.

million, and again reduced the AIM-9X FY97 President's Budget request by $10.9 million.

Fiscal Year	RDT&E	Procurement	Total program
94	628.0	2223.5	2851.5
94	640.2	2213.5	2853.7
95	648.3	2257.8	2906.1
96	531.4	1932.6	2464.0
97	520.5	2072.5	2593.0
98	532.7	1952.7	2485.4

Table 5-2, Annual Revisions of Total Life-Cycle Program Costs
Source: AIM-9X Program Office

Figure 5-11 is a graphic depiction of total program costs from Table 5-2.



1. DoDR 5000.2R designates programs with procurement of $2.135 Billion or more as ACAT I and is minimum axis value.

Figure 5-11 Source: AIM-9X Program Office

F. SUMMARY OF CAIV IMPLEMENTATION INTO AIM-9X

As summarized in Table 5-3 the implementation of CAIV into the AIM-9X program resulted in a diverse range of cost reduction activities during all stages of program development. Cost-performance trades began early in program development during the cost and operational effectiveness study of possible missile design options. The user's decision not to develop a new rocket motor and new warhead for the AIM-9X Sidewinder, but to continue use of existing AIM-9M Sidewinder components is another example of cost-performance trades.

The Affordability IPT continue to look for cost-performance trades using Raytheon's engineering cost model, and the CAIV ECP process. Use of Raytheon's cost model, AUPC cost management system, and Price as a Technical requirement are significant factors in the program's ability to set aggressive cost objectives.

AIM-9X cost reduction activities also include development of quantifiable producibility metrics, development of contract incentives, such as the PPCC, 0/100-share ratio, and the award fee structure, and development of contractor risk mitigation plans.

Finally, the cost reduction activities took place in a changing work environment that fostered closer relationships between contractor and government personnel, and an environment in which the program office retooled its organizational structure from a functional structure to an IPT structure.

CAIV Objectives	Pre-DEM/VAL	DEM/VAL	E&MD
Cost-Performance Tradeoffs	• COEA design studies • Use of existing AIM-9M components	• "Flagship" CAIV program • Review AS-5780 • Eight req't changes • Restrict trade space to non-KPPs	• "Flagship" CAIV program • Review AS-5780 • Focus on technical problems • "Think CAIV"
Setting Aggressive Cost Objectives	• Engineering cost model did not exist • Historic cost analysis • Rules of thumb analysis	• Contractor-established AUPC target • Systems Engineering approach • Develop engineering cost model to assist cost-performance trades	• AUPC cost management – Cost flow down – CAIV ECP process – "What if" analysis • Integrate cost model with design • Price as a Technical Requirement • Engineering cost model used to identify CAIV opportunities
Metrics		• Develop quantifiable producibility metrics	• Use quantifiable producibility metrics • Affordability IPT meets quarterly to review metrics • Reduce T1 price by additional 10%
Incentives	• Competition for contract award	• Contractor – Competition for contract award – Source selection-life cycle costs equally important as E&MD & LRIP contracts • Program Office – OSD policy – Program stability – Individual – Professional • User – Save money	• Contractor – Award Fee – 0/100 share ratio – PPCC • Program Office – OSD policy – Program stability – Individual – Professional • User – Avoid costs – Avoid technical problems – "Not driving the CAIV train"
Risk Management	• Select mature technologies • Avoid costs and risks	• Develop risk identification plans • Develop risk Mitigation plans	• Risk identification plans • Risk mitigation plans reviewed quarterly

Table 5-3, Summary of AIM-9X Cost Reduction Activities

VI. CAIV AS A STRATEGIC MANAGEMENT CONTROL SYSTEM

A. OVERVIEW

Previous chapters discussed environmental forces affecting DoD—budgetary pressures, modernization requirements and military performance requirements—that influence and incentivize participant's behaviors, and which in turn drive the cost of weapon systems. Addressing this relationship has shaped a new acquisition strategy focused on affordability. However, as discussed in the previous chapters the pressures on and incentives for individual decision-makers may not be consistent with a focus on affordability. If the new acquisition strategy is to succeed, management control of individuals, and their cost activities is required (Figure 6-1).

Figure 6-1

It can be argued that CAIV has the potential to meet this need by functioning as a management control system. Using the AIM-9X case study, can this research characterize CAIV as a management control system? If it can, how did the CAIV control system change AIM-9X organizational behaviors and incentives? Did it change the environment in which those decisions took place? I address these questions in three parts to this chapter. The first part compares CAIV objectives, as implemented by the AIM-9X program office, to the generic management control model developed in Chapter IV to analyze the proposition that CAIV is a strategic management control system. The second part uses Simons' model of *Levers of Control* (1995) to discuss in what ways the AIM-9X organization used the CAIV control system. The last part discusses possible barriers to the implementation of CAIV when extended beyond the AIM-9X program.

B. STRATEGIC MANAGEMENT CONTROL SYSTEM

Robert Anthony states, "in order to be useful, information about any subject needs to be organized around a framework." This section analyzes CAIV in a management control framework, which may assist program managers in how to think about CAIV. Paraphrasing Anthony, program managers should recognize CAIV as one part of a broader process that has to do with control in an organization. The following section provides one perspective on the broader process.

1. Strategic Management Control System Model

I previously noted the varied definitions of CAIV—strategy, initiative, policy, process, and philosophy—and the ambiguity this causes, which may effect its implementation. A clear definition of CAIV emerges when its objectives are thought of in a management control context. The following subsections compare CAIV objectives,

as implemented by the AIM-9X program office, to each element of the model. Reproduced below are the elements of the generic management control model from Chapter IV:

- Plan organizational goals
- Communicate goals and objectives
- Determine outputs and standards for assessment
- Detect information, activities, or behaviors
- Rewards, incentives, and sanctions
- Evaluate information about activities, or behaviors against standards
- Initiate feedback to ensure organization stays on strategic course

a) Plan Organizational Goals

The CAIV control system helps shape organizational goals by providing the linkage between DoD strategy and AIM-9X organizational goals and objectives. The CAIV control system provides specific objectives, which integrate DoD acquisition strategy with AIM-9X organizational goals and objectives. CAIV established producibility and affordability exit criteria that the program must achieve prior to OSD approval for production. The AIM-9X organizational goals and objectives are to meet exit criteria contained in the Acquisition Decision Memorandum issued by the Milestone Decision Authority (Appendix B). There is a direct relationship between the exit criteria and DoD acquisition strategy.

- Analyze cost experience and price projection to confirm the ability to produce AIM-9X missiles at the price established in the LRIP contract.

- Demonstrate critical manufacturing processes using manufacturing capabilities, factory transition, and design stability metrics.

The affordability and producibility exit criteria are a major part of the CAIV control system. A contractor-government team interactively developed the planning goals, and made them a part of the CAIV control system in order to set the direction, tone, and focus for the organization's people, behavior, and tasks. Implementation of DoD acquisition strategy is accomplished through the CAIV control system and its establishment of AIM-9X organizational goals—the producibility and affordability exit criteria.

b) Communicate Goals and Objectives

The CAIV control system uses a hierarchy of IPTs to communicate DoD acquisition strategy and AIM-9X organizational goals and objectives through the organization. IPTs are the primary method the control system uses to communicate goals and objectives, and to initiate and receive feedback. Communication of AIM-9X goals and objectives through the organizational structure is essential for effective management control. As I previously noted, according to the *DoD Guide For Leading Successful IPTs* (1995), the teams operate under the broad principles of open discussions, with no secrets, continuous "up the line" communication, and issues raised early and resolved early. These IPT principles are the requirements for effective communication.

The CAIV control system uses three principle IPTs—the Overarching IPT, the Cost-performance IPT, and the Affordability IPT to communicate goals and objectives. The Overarching IPT provides strategic direction and communicates the importance of the DoD affordability strategy to the subordinate Cost-performance IPT.

The Cost-performance IPT, chaired by the program manager, provides program oversight and review. It is the vehicle to communicate program status and unresolved issues up or down the organizational chain. Finally, the Affordability IPT communicates organizational goals to individual contractor design teams at Raytheon.

To help facilitate communication within the CAIV control system, the AIM-9X program office reorganized its functional organizational structure into an IPT structure. The AIM-9X IPT organizational structure is a vehicle for an interactive communication process. For example, government and contractor personnel used this process to establish the AUPC cost target during DEM/VAL. Inclusion of the AUPC cost target in the E&MD contract communicate to the contractor the direction in which it should proceed. Similarly, the contractor's AUPC cost management system, and its use of cost models early in the design process, communicate the importance of affordability to each member of Raytheon's design teams.

c) Determine Outputs and Standards for Assessment

OSD CAIV policy requires the program manager to set aggressive, but realistic cost objectives early in the design process. OSD CAIV policy also requires the use of metrics, a system of quantifiable measurements, to assess program progress. The CAIV control system includes several metrics to determine if the program can achieve its planning goals. Since the planning goals require meeting affordability and producibility exit criteria prior to production approval, the Affordability IPT uses the following metrics to set standards and determine outputs:

- Average Unit Procurement Cost (cost of 5000th unit)
- Average Unit Cost (average cost of one production lot)

- Procurement Price Commitment Curve
- Producibility Metrics

The IPT uses a contractor-established missile Average Unit Procurement Cost, and contracted prices, called Average Unit Cost, for the first three production lots, as determinants in whether the program can achieve its exit criteria. Additionally, the Affordability IPT established a joint government-contractor goal of lowering the cost of "T1", the Average Unit Cost of the first production lot, 10 percent below the contracted price (Figure 6-2).

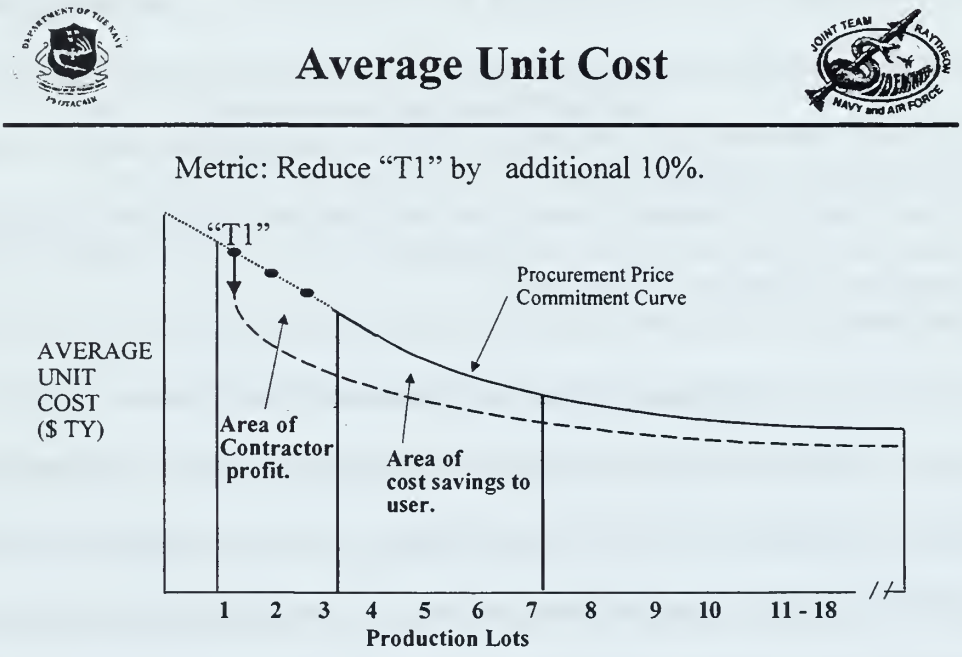


Figure 6-2 Source: AIM-9X Program Office

A downward adjustment in the cost of the first production lot allows the contractor to increase profit an additional 10 percent, and saves the user in the long run by decreasing future defense budgets required for production lots 4-7, or allows the user the option to buy more units.

The contractor-established Procurement Price Commitment Curve for production lots 4-7 is another standard the Affordability IPT will use to assess program progress towards meeting the affordability and producibility exit criteria. If Raytheon prices meet or fall below the Commitment Curve, they will retain sole source production of AIM-9X and not have to compete against another defense contractor. They also retain configuration control, depot maintenance, and not endure government oversight.

Lastly, the AIM-9X program uses producibility metrics to determine if the program office and contractor are managing to achieve its unit cost goals. Producibility metrics are a component of the management control system. Demonstration of manufacturing capability, design stability, and factory transition to full rate production are the standards for assessing weather the program can exit from the E&MD stage of development and proceed into production.

d) Detect Information, Activities, or Behaviors

This control element is composed of components of the control system, such as a series of reports that detect information for evaluation. The AIM-9X program uses several components of the CAIV control system to detect information, activities, or behaviors:

- Contractor Producibility Reports
- Cost Model Outputs
- CAIV Engineering Change Proposals

The Affordability IPT uses contractor producibility metrics reports to predict whether the contractor's design teams can meet its cost requirements. The reports allow the Affordability IPT to predict whether the contractor can produce at the

throughput and yields required to meet unit cost objectives prior to the start of low rate initial production.

Contractor design teams use outputs from its cost model to predict if it can meet its cost requirement. Since Raytheon's AUPC cost management system establishes a cost requirement for each design team, the cost model forces the design team to consider alternative designs, conduct 'what if" analysis, and study the implications of each potential decision.

The cost model is a component of the control system that can detect cost-performance tradeoff opportunities, and allow engineers on the design team to think about cost-performance tradeoffs in order to meet its cost requirement. The CAIV ECP process is a component of the system, which puts the cost-performance tradeoff opportunities into motion.

Rewards, incentives, and sanctions are tied to this component of the CAIV control system, and is covered in the next subsection.

e) Rewards, Incentives, and Sanctions

The CAIV control system uses rewards, incentives, and sanctions to ensure that actual performance meets or exceeds standards. The AIM-9X program office uses the CAIV control system to incentivize the contractor to lower production prices, which yields larger profit. If the AIM-9X program manager decides that actual performance meets or exceeds standard performance, he can financially reward the contractor. For example, if the contractor can perform below the contracted prices set for the first three production lots, the 0/100-share ratio allows the contractor to keep 100 percent of the savings. If the contractor does not perform to its Commitment Curve, the

AIM-9X program manager could issue sanctions by competing production lots 4-7 instead of exercising an option to continue sole source production. CAIV thus incentivizes the contractor to lower production prices, and it rewards the contractor with savings generated from lower production prices.

Additionally, the CAIV control system uses award fees to provide incentives to the contractor to meet producibility and affordability exit criteria—the program's organizational goals. Thus the control system ties rewards to organizational goals, and ultimately, to DoD acquisition strategy.

Rewards, incentives, and sanctions for the contractor are easy to identify because of the profit motive. Evidence from the AIM-9X case indicate that rewards and incentives for the program manager is harder to identify. However, the program manager appears motivated by direction from DoDD 5000.2R, a desire for program stability, and professional rewards, such as promotion and peer esteem, which incentivize the AIM-9X program manager to meet organizational planning goals. Later in this chapter I discuss user incentives.

f) Evaluate Information About Activities, or Behaviors Against Standards

In the CAIV control system much of management control is accomplished through the interaction and coordination of three key managers—the Affordability IPT manager, the AIM-9X program manager, and the Raytheon program manager—and their respective IPTs. The IPTs not only function as a communication vehicle in the control system, but they also function as an evaluator of information.

The interaction process between the three key managers, and their respective teams, determine whether differences in actual performance measures and

standard performance measures warrant action. Wade Smith and the Raytheon design teams, Major Goldstien and the Affordability IPT, Captain MacKenzie and the Cost-performance IPT, evaluate and coordinate information from the CAIV control system to determine if the program can meet organizational goals, and implement the DoD affordability strategy. The team evaluates and coordinates information from contractor producibility reports, cost model outputs, and CAIV ECP proposals against the producibility and affordability metrics. A determination is made as to whether action is required by a team in order to meet organizational goals.

g) Initiate Feedback

The CAIV control system uses a hierarchy of IPTs as its feedback mechanism. It is through a series of linked IPTs that information from the CAIV control system flows up from contractor-level IPTs, to AIM-9X program management, and ultimately, to DoD leadership. Figure 6-3 illustrates the linkage. For example, cost model outputs and producibility reports flow from the contractor design IPTs, to the Affordability IPT, where they compare the information to the metrics. Information from this process flows up to the AIM-9X program management IPT, where the information is compared to the organizational planning goals. Eventually, information from the CAIV control system is linked to the CPIPT, as part of its oversight and review function, and finally to the OIPT, as part of its strategic guidance function.

Figure 6-3

The IPT structure provides a clear linkage for the flow of information from the CAIV control system from the contractor, to the program office, to oversight and review teams, and ultimately, to the Milestone Decision Authority. The IPT feedback mechanism ultimately links the contractor and program office performance to DoD acquisition strategy.

2. Summary

A managerial framework begins to emerge when seemingly disjointed information from the AIM-9X case study is put into a management control context. One of the problems with the DoD CAIV working group report is that its list of CAIV objectives does *not* a unifying perspective. The report merely lists CAIV objectives with no managerial framework to support it. Too many definitions of CAIV exist and priorities differ about what is important in CAIV implementation.

When the implementation of CAIV into the AIM-9X program is viewed in the context of management control system we can observe the components of the control system. They are the exit criteria, or planning goals and objectives, a communication mechanism, or the linked IPTs, the producibility and affordability metrics, which are the standards for assessments, evaluation, and feedback. CAIV is a strategic management control system that helps ensure the implementation of DoD acquisition strategy. It is strategic in the sense that the hierarchy of IPTs links the lowest levels of organizational behavior to DoD acquisition strategy.

It is in the CAIV control system that organizational participants can consider a whole range of cost reduction activities, not just cost-performance tradeoffs that some consider the essence of CAIV. The CAIV system can control behaviors and incentives that lead to decisions affecting cost. It is a control linkage between acquisition strategy, organizational goals and objectives, and organizational behavior.

C. CAIV: SIMONS FOUR LEVERS OF CONTROL

How is the strategic CAIV management control system used in the AIM-9X program? Evidence from the AIM-9X case study seems to indicate that it is a hybrid of all four levers of control (Simons, 1995) discussed in Chapter IV.

1. Belief System

Simons defines beliefs systems as an explicit set of basic values, purpose, and direction. "These values are linked to the business strategy of the firm." (Simons, 1995, p.34) The CAIV objectives listed by the OSD working group report are characteristic of a belief system in that they represent a new DoD direction, and a new focus on affordability. The *DoD Guide For Leading Successful IPTs* (1995) represents a change

in working relationships between government and contractor personnel. Major Goldstien, Affordability IPT manager, and Wade Smith, Raytheon AIM-9X program manager both commented on the increased level of trust and open communication between government and contractor personnel.

The use of mission statements in the CAIV control system communicates the new DoD strategic direction to members of its organization. They provide an opportunity to create new working relationships between government and contractor personnel.

- AIM-9X mission statement: Our contractor/government team will deliver to the warfighter an affordable AIM-9X weapon system that meets stated performance requirements within schedule.
- Affordability IPT mission statement: To recommend opportunities for reducing AIM-9X costs from initial product development through the entire life cycle.

The statements are an explicit set of beliefs that define DoD strategic direction, AIM-9X organizational goals, and the focus of Affordability IPT work activities. They provide guidance for behaviors in the organization and make it acceptable for engineers and management to question the user's requirement and consider cost-performance tradeoffs.

2. Boundary System

Simons states that "boundary systems delineate the acceptable domain of activity." (Simons, 1995, p.39) Boundary systems are "formally stated rules and limits to the conduct of business." (Simons, 1995, p.178) When CAIV is thought of in a management control framework, boundaries as to what is acceptable behavior begins to

emerge. New boundaries appear and old boundaries fade way. For example, "requirements creep" from the user community, and contractor "gold-plating" behavior is no longer expectable behavior. Engineers are no longer allowed to add "bells and whistles" to generate higher profits. Instead, the CAIV control system encourages engineers "to think CAIV," and consider cost-performance tradeoffs in order to meet the producibility and affordability exit criteria. The result is that engineers may step into the user's boundary and begin to question the user's requirement.

The AIM-9X Cost-performance IPT is a useful mechanism for controlling acceptable behaviors and incentives. From the cost savings generated by the AIM-9X program, evidence exists which suggest that controlling behavior was key to controlling costs. Examples from the case study include user willingness to avoid developmental cost of a new rocket motor and warhead for the AIM-9X missile prior to DEM/VAL, and the eight Operational Requirements Document changes prior to E&MD.

The AIM-9X program manager's decision to limit trade space to non-KPPs is another example of setting boundaries in the tradeoff process. He uses the CAIV control system to establish a boundary for acceptable behavior.

3. Diagnostic System

Components of the CAIV control system, and the rewards and incentives attached to the system, are characteristic of a diagnostic control system. The hierarchy of IPTs is the feedback and control mechanism that monitors progress in achieving AIM-9X organizational goals. The Affordability IPT established a set of producibility metrics and use contractor reports to evaluate progress. The IPT also conducts quarterly reviews of the metrics to ascertain whether the outputs continue to relate to the program's affordability and producibility exit criteria.

The AIM-9X program also uses output data from other components of the CAIV control system—Average Unit Cost, PPCC, and the cost model output—as diagnostic control. The Affordability IPT monitors the outputs and evaluates whether the program can achieve its exit criteria.

Rewards and incentives are linked to goal achievement. For example, the program manager uses award fees to incentivize the contractor to meet program management criteria in the following areas—program management, systems engineering, technical performance, producibility, and reliability. The 0/100-share ratio and PPCC also incentivize Raytheon to meet established cost targets and contracted prices.

4. Interactive System

The CAIV control system is the vehicle that focuses management on strategic uncertainty. Interactive systems focus organizational attention on strategic uncertainties and provoke the emergence of new initiatives. (Simons, 1995, p.180) Figure 6-4 provides the framework for how the program interactively used the CAIV control system.

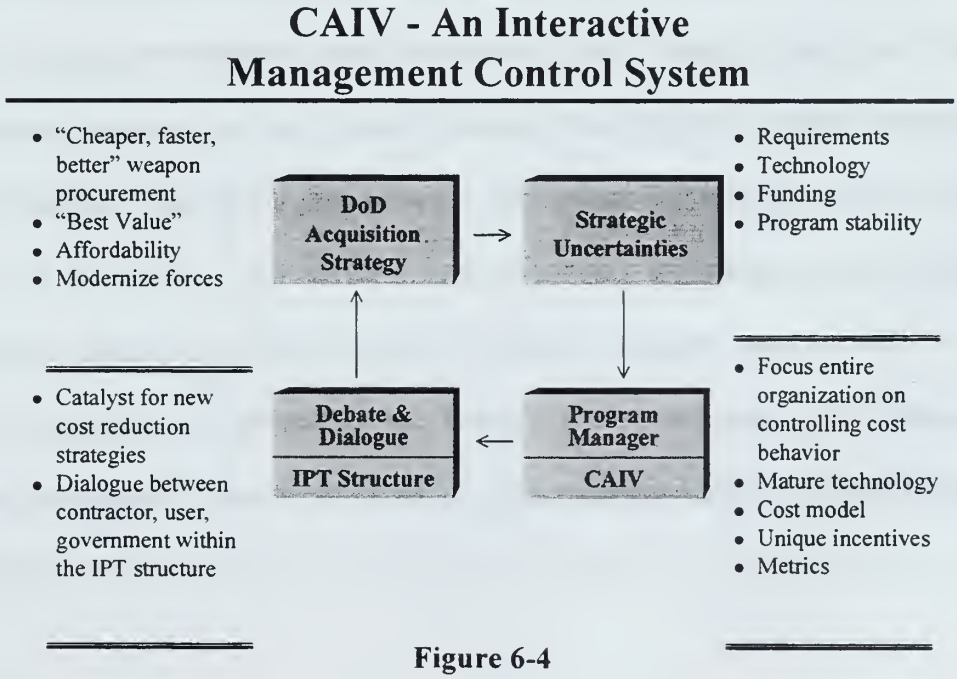


Figure 6-4

In the upper left hand quadrant is the DoD acquisition strategy. In Chapter II, I discussed the DoD requirement to procure weapons faster, better, and cheaper. (Gansler, 1998) The strategy is to focus on acquiring "best value" products and services. (Kaminski, 1995) The focus is on affordability in order to pay for modernization. (Gansler, 1998)

In order to implement this strategy, the AIM-9X program manager interactively uses the CAIV control system to focus organizational attention on strategic uncertainties. As depicted in Figure 6-4, the search for uncertainties targets technical risk, operational requirements, and funding as sources of disruption. After identifying the uncertainties, the bottom right hand quadrant of Figure 6-4 illustrates the program manager using the control system to deal with the uncertainties—controlling cost behavior to prevent requirements creep and gold-plating behavior, selecting mature missile technology, developing an engineering cost model to assist in cost-performance tradeoffs, and using appropriate metrics and standards for assessments.

Management uses the CAIV control system to signal to members of each IPT what is important to the organization. Debate and dialogue between contractor personnel, government personnel, and the user provides a catalyst for finding new cost reduction activities to deal with strategic uncertainty. Specifically, the program interactively used the CAIV control system in the following ways:

- The program manager frequently interacted with subordinate and superior IPTs to ensure the continuation of cost control activities and implementation of the DoD affordability strategy. The program manager shared information generated by the CAIV

control system with team members from all levels of the organization, then evaluated the information in an IPT process to determine if action was required.

- Selection of a mature missile design technology for the AIM-9X missile significantly reduced strategic uncertainty. The program manager opted to use a mature, more predictable and affordable technology for the AIM-9X missile development, which reduced cost risk and uncertainty.

- Changing the AIM-9X organization from a functional structure to an IPT structure meant that individuals would have to learn to work in a new environment. Government and contractor personnel learned to work in an environment that fostered teamwork, trust, and cooperation.

- Government and contractor management began to comprehend the importance of the DoD affordability strategy and the need for effective cost control. Through an interactive process a government/contractor team established the AUPC cost target, prices for the first three production lots, average unit cost for the first three production lots, and the PPCC for lots 4-7 as means to achieve cost control.

- A contractor/government team established specially designed incentives unique to the program in order to reduce costs. The program's award fee plan, 0/100 share ratio plan, and PPCC curve, unique to the AIM-9X program, was established through an interactive CAIV process between a team of government and contractor personnel.

- Engineers on each Raytheon design team began to learn the importance of owning a cost requirement, as well as technical and performance requirements. Raytheon integrated its cost model down to all levels of the contractor development team. Price as

a Technical Requirement is the result of an integrated team analysis, and all team leads have responsibility for meeting its required cost goal. The design teams learn early in the design process whether its cost requirement can be met by applying "what if" statements to the cost model.

- Through debate and dialogue in the Affordability IPT and the Cost-Performance IPT the program manager triggers the search for new opportunities to reduce cost through cost-performance tradeoffs and other cost reduction activities. The Affordability IPT provides a "focus and a forum" for the continuing search, such as through the CAIV ECP process. The Cost-Performance IPT ensures the user is involved in the tradeoff process and the search for new requirements tradeoff opportunities.

- Through debate and dialogue in the IPT process the user learned that requirements creep could not be tolerated in an environment focused on affordability. Contractor personnel learned the same lesson in that the IPT process no longer tolerated gold-plating behavior.

D. SUMMARY

This chapter analyzed and discussed CAIV from the viewpoint that is a management control system. Components of the CAIV control system were identified using the generic management control model from Chapter IV. The AIM-9X exit criteria are the organizational goals and objectives. The IPT structure is the vehicle the program uses to communicate DoD strategy and program goals and objectives. The producibility and affordability criteria are the program's standards for assessment when measuring progress towards meeting the organizational goals and objectives using information

generated from the CAIV control system. The CAIV control system is strategic in the sense that it is responsible for implementing DoD acquisition strategy.

Additionally, the preceding discussion described how the AIM-9X program used the CAIV control system in ways that resemble Simons' *Levers of Control* (1995). From viewing the CAIV control system in the AIM-9X case study it appears that it is a hybrid of all four levers of control. The CAIV control system appears to facilitate the implementation of DoD acquisition strategy when it is used as a belief system, boundary systems, a diagnostic system, and an interactive system.

VII. CAIV IMPLEMENTATION ISSUES

A. OVERVIEW

Special issues exist when a program implements CAIV. The issues emerge from the author's previous experience with the CAIV implementation process, from the AIM-9X case study, and its supporting research. The next section discusses program ownership, cost models, and trade space as special issues to consider when implementing CAIV into program management that may affect the level of control a program has in the management of cost reduction.

B. PROGRAM OWNERSHIP

The literature makes explicit that the key tenant to CAIV is increased user involvement (Rush, 1995), but it is not clear that the mere existence of cost objectives, and a formal tradeoff process, creates incentives for the user to actively participate. The CAIV working group state "a more formal cost-performance tradeoff process will motivate both government and industry by clarifying objectives, fostering feedback, and empowering decision-making." (Longuemare, 1995) From the user's viewpoint, it is not clear that this is actually true. Evidence to the contrary exists from the AIM-9X case study in Stutz's comments about "not driving the CAIV train." (Stutz, 1998) The issue is important because it is the user's requirement that is subject to tradeoffs.

The user may not actively participate in the tradeoff process because the user and the program manager work in different organizational structures. The reporting chain of command, culture, behaviors, and incentives are different for the user and the program manager. Differences exist between the user and the program manager as to their

respective organizational roles and cultures. If indeed, "the central feature of CAIV is the tradeoff process," then the differences in organizational roles and cultures may be a barrier to effective implementation. (Rush, 1997, p.165) "Changing the culture regarding lesser but acceptable performance is critical to successful implementation of CAIV." (Rush, 1997, p.165) The difficulty lies in changing two cultures in two separate organizations. As indicated by remarks by Dr. Oliver (PDUSD (A&T)) to the CAIV Flagship Workshop, the existing organizational structures do not allow the user to actively participate in the CAIV process as much as possible. (Oliver, 1998)

From Figure 6-5 we can see that the user controls the decision support system for requirements generation, and controls the budgeting process decision support system, which determines the amount of financial resources for weapons development and production. The program manager controls the acquisition management decision support system. What is the user's incentive to participate in the acquisition management's decision support system, which is outside his organizational structure, and may result in lower performance standards? Why trade off a funded requirement that had to complete an exhaustive review process prior to approval?

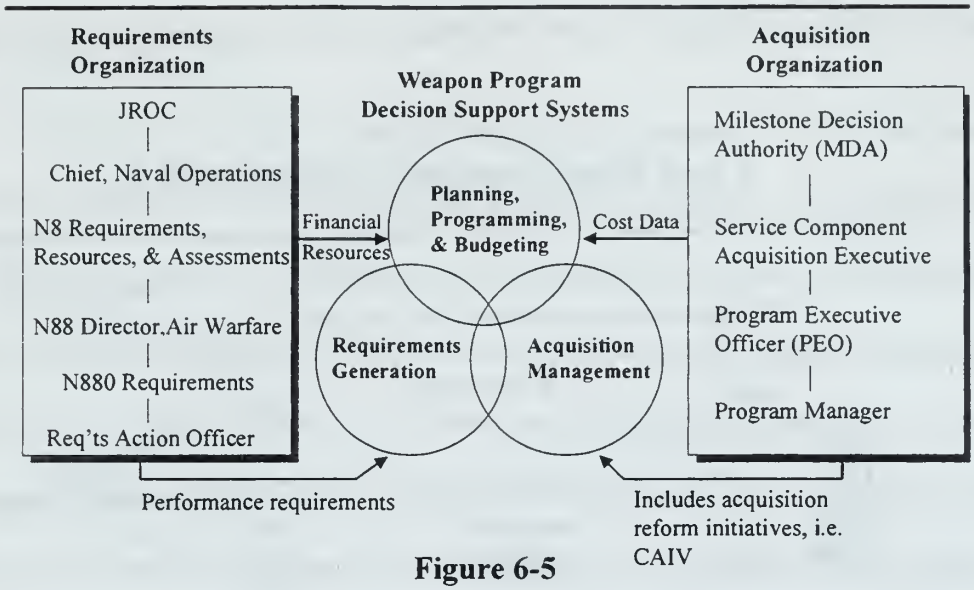


Figure 6-5

Since the user controls two of the three decision support systems, and is not in the acquisition manager's organizational structure, the user could possible take exception to specific elements of CAIV policy. For example, Dr. Land, from Defense Systems Management College, states that the program manager should give a continuous and honest assessment of trading off requirements to meet cost objectives. (Land, 1997, p.28) The user may take exception to a program manager trading off his requirement.

C. RELATIONSHIP BETWEEN COST AND REQUIREMENTS

A particular popular notion within the Pentagon to support the idea of cost savings is that CAIV can achieve a "80 percent solution." (Kaminski, 1995) In other words, CAIV can achieve 80 percent of the requirement at half the cost. This relationship may be a convenient way to think about cost-performance tradeoff relationships, but may bear little resemblance to the real relationship. The statement assumes such cost-performance relationship models exist, and that defense contractors

can predict, down to the sub-component level, cost versus performance relationships such as the one depicted in Figure 6-6. Also, cost-performance models may be system specific, and may not have the level of detail required to express a cost-performance

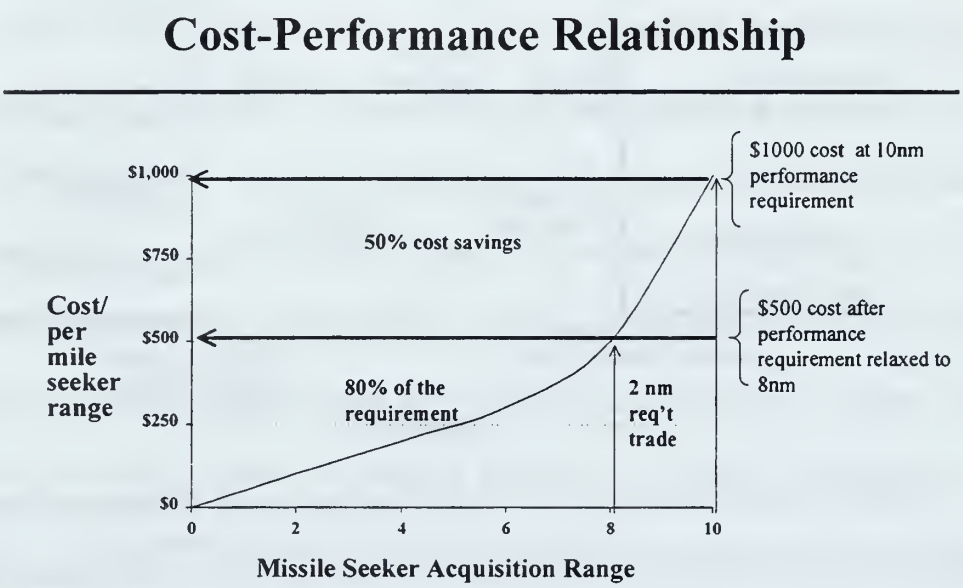


Figure 6-6

relationship implied by the 80 percent solution. For instance, is there a cost-performance tradeoff relationship that exists between missile seeker acquisition range and cost? Is the relationship exponential or linear? Is technology a factor in the relationship?

In the AIM-9X case, Wade Smith stated that only in an indirect way could the Raytheon cost model predict relationships such as the one depicted in Figure 6-6. As I mentioned in Chapter III, Dr. Rush states that such relationships are a key factor in the tradeoff process. From my experience as the AIM-9X requirements officer, and from the AIM-9X case study, the Raytheon cost model cannot predict this type of relationship. If it did, it would certainly aid the user, and program manager, in getting beyond the cost-

performance tradeoffs that have already occurred in the AIM-9X program, in the search for further cost reductions.

D. TRADE SPACE

The idea that the program manager and Cost-Performance IPT can trade away the user's performance requirements implies the existence of tradeoffs in some defined trade space. However, ambiguous definitions of trade space exist in the CAIV literature. For example, Higgins describes KPPs as those "requirements that the program manager may not trade off." (Higgins, 1997, p. 46) In other words, the program manager can trade off system performance requirements as long as KPPs are met. DoDD 5000.2R (1996) makes no such distinction between system performance parameters and KPPs in the trade off process. It does say however, that if changes to threshold values are required, the program manager shall ensure that the changes are brought forward to Operational Requirements Document approval authorities. This statement implies that all requirements, regardless of status, are tradeable. On the other hand, Dr. Rush, from Defense Systems Management College, states that for KPPs the only trade space for KPPs exists between the threshold and objective values. (Rush, 1997, p. 163)

Two other definitions of trade space include minimizing the number of performance requirements or establishing upper and lower cost objectives. The user can decrease the number of performance parameters, which creates trade space by allowing the contractor to explore less costly design options. (DoDD 5000.2R, 1996) The Cost-Performance IPT can "shape" the requirements if "true" user requirements are kept to a minimum. Also, trade space can exist between the cost objective of a weapon built to

Trade Space

Notional missile performance requirements.

Is it difference between threshold and objective values?

	Performance Requirements	Threshold	Objective
KPPs are not tradeable, but other system performance requirements are tradeable?	*Missile Off Boresight Angle	40 degrees	50 degrees
	*Missile Reliability	1000 hrs	2000 hrs
	*Probability of Kill	0.5	0.9
	Seeker Acquisition Range	20 nm	35 nm
	Launch Altitude	40,000 ft	60,000 ft
	Launch Speed	1.5 mach	2.0 mach
	Per Unit Cost Range	$100K	$150K
	*Key Performance Parameters	Is it difference between threshold and objective cost objectives?	

Figure 6-7

threshold parameters, and the cost objective of a weapon built to objective parameters. (Oliver, 1998) Figure 6-7 summarizes the definitions of trade space.

The point of the preceding discussion is that trade space definitions run counter to at least some of the user's behaviors and incentives discussed in the previous chapter, and could adversely affect a program's use of the CAIV management control system by:

- Expecting increased weapon capabilities with little regard to cost
- Setting detailed requirements early in the process to legitimize the requirement
- "Gold-plating" or requirements creep
- Expecting cutting-edge, immature technology to further legitimize the requirement

The AIM-9X CAIV control system overcame this barrier by the use of its IPTs. Although the user is "not driving the CAIV train," he certainly did not ask for cutting

edge technology, the program manager selected a mature technology that would reduce program risk. Additionally, there was not one instance of "requirements creep" in this program. User participation in the Cost-Performance IPT process was effective controlling behaviors that lead to higher costs.

E. SUMMARY

This chapter discussed special issues—program ownership, cost models, and trade space—that the program manager should consider during the implementation of CAIV, which may affect the use of CAIV as management control system.

VIII. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

A. SUMMARY

CAIV has many descriptions—a strategy, an initiative, a process, a target costing methodology. DoD and DON policies differ about what is the most important cost reduction activity. Are cost-performance tradeoffs the "essence" of CAIV, or is it any cost reduction activity? This research attempts to demonstrate that CAIV is a product of a need to change the way the acquisition community conducts business. The implementation of an acquisition strategy based upon affordability is critical to DoD if it is to afford modern weapon systems and increase procurement to $60 billion. When used in the sense of implementing strategies CAIV is a strategic management control system. The list of CAIV objectives is *not* a "conceptual approach," or a managerial framework that program managers can refer to in their implementation of CAIV. But when thought of in the context of a management control system, partly responsible for the implementation of DoD acquisition strategy, a managerial framework takes shape, which can assist the program manager in its implementation of CAIV. Additionally, the CAIV control system functions in a way that resembles Simons' model of levers of control. A program can use the CAIV control system as a belief system, a diagnostic system, a boundary system, and an interactive system. A program manger can use the CAIV control system in any of the four ways to facilitate the implementation of strategy.

B. CONCLUSIONS

- When control is used in the sense of implementing strategies, CAIV has the attributes of a strategic management control system. The focus of DoD acquisition

strategy is to reduce costs by transforming its business practices into "best commercial practices," which will enable "faster, cheaper, and better" weapon systems production. Implementation of the CAIV control system helps the program manager engage in control activities that helps DoD achieve its desired outcomes.

- The proposition provides program managers a theoretical construct, or framework, about how to unambiguously think and apply CAIV in their programs. The generic management control systems model, and Simon's four levers of control, is a framework that can assist program managers in the implementation of CAIV.

- The hierarchy of IPTs is a critical communication component to the CAIV control system. The IPTs link the communication of DoD acquisition strategy and AIM-9X organizational goals and objectives from the top of DoD leadership down to individual contractor teams. Representation of all stakeholders on the IPTs serves as a communication mechanism, and enables the break down of organizational boundaries that can hinder effective communication.

- The hierarchy of IPTs is a critical control component to the CAIV control system. The IPTs are an effective control mechanism for controlling participant's behaviors and incentives that lead to decisions, which can affect higher costs. For example, the evidence indicates that requirements creep did not occur in this program due in large part to the IPT process. The IPT facilitated a teaming arrangement with government and contractor personnel, which built trust and cooperation among the IPT members.

- Within the CAIV control system use of the Cost-Performance IPT is a way to break down boundaries by including members from different organizations. In other

words, all stakeholders are included in the decision-making process. As a stakeholder, the user "owns the requirement," and therefore, the user is probably the biggest stakeholder. Inclusion of the user into the Cost-Performance IPT helps change the user's behavior by making him a part of the cost-performance tradeoff process.

- The AIM-9X program attempts to control behavior by using its IPT structure, particularly the Affordability IPT, to communicate the direction in which the organization should proceed. For example, the Affordability IPT gets people "to think CAIV". It has communicated a need to change the environment, and made it acceptable for engineers to recommend cost-performance trades.

- Cost-performance tradeoffs do not appear to be the "essence" of CAIV, but rather CAIV may be characterized as a control system encompassing a range of cost reduction activities. It is evident from the AIM-9X case study that cost-performance tradeoffs were not the primary cost reduction activity. The scope of work in the Affordability IPT went beyond cost-performance trades to encompass many cost reduction activities. They focused on producibility, manufacturing practices, cost modeling, and life cycle cost reductions, in addition to formal cost-performance tradeoffs through the CAIV ECP process.

- The CAIV control system focused organizational attention on affordability, but transformation of the AIM-9X organization into an IPT structure resulted in a change in the working environment, which made it possible to change participant's behaviors and incentives, and helped facilitate the change in focus.

- The CAIV control system must provide incentives to the user to actively participate in a decision support system that is outside his organizational structure. It

must produce cost models that can accurately predict the relationship between cost and operational requirements, and define trade space in a way that agrees with all stakeholders in the control system.

C. RECOMMENDATIONS

- DoD must get beyond the "financial activities and property accountability" connotation of management control and think of management control systems as strategic. Management control is *not* a "paper exercise," but a system, which is a key factor in the implementation of strategy.
- Program managers should use CAIV as the primary control *system* to reduce costs and focus the entire organization on the need to implement DoD strategy.
- Program managers should consider special issues, such as—program ownership, trade space, and cost models—as those that could possibly affect the implementation of a CAIV control system.
- Program managers should implement CAIV with the knowledge that CAIV encompasses a wide range of cost reduction activities, not just cost-performance tradeoffs.

D. AREAS FOR FURTHER RESEARCH

1. Cost savings versus cost avoidance

Is the purpose of CAIV to save real budgeted dollars to cure "sick", under-funded programs, or is avoidance of cost the purpose? A GAO report includes data from 63 major military weapon programs on acquisition reform's effect on weapon system. (GAO/NSAID-98-31, p.1) The report included budgeted and unbudgeted cost reductions. The military services estimated acquisition reform reduced the cost of major

weapon programs by $29 billion. Only $8 billion is in budgeted reduction, and $21 billion is in unbudgeted cost reductions, or cost avoidance.

GAO concludes that to date the extent and degree to which savings generated by CAIV will be available to help fund DoD investment accounts for modernization remains in question. (GAO/PEMD-98-31, p.6) The same report concludes that acquisition reform initiatives such as CAIV have only been in use for a few years, and their full impact is not yet assessed. (GAO/PEMD-98-31, p.6) Additional research is required to assess whether acquisition reform savings are of sufficient magnitude to make a positive difference in DoD investment accounts.

2. Formulation of Acquisition Strategy

It was beyond the scope of this thesis to conduct an in depth study into the formulation of acquisition strategy, but a deeper understanding of how DoD leadership formulates strategy and the effectiveness of management control systems in the implementation of strategy would benefit the acquisition community. It would also aid in the development of management control thought in DoD from a system of internal controls that safeguard assets to a system responsible for implementing acquisition strategy.

APPENDIX A—SIMON'S FOUR LEVERS OF CONTROL

Lever #1: Beliefs Systems

What explicit set of beliefs that define basic values, purpose, and direction, including how value is created; level of desired performance; and human relationships

Why to provide momentum and guidance to opportunity seeking behaviors

How
- mission statements
- vision statements
- credos
- statements of purpose

When
- opportunities expand dramatically
- top managers desire to change strategic direction
- top managers desire to energize workforce

Who
- senior managers personally write substantive drafts
- staff groups facilitate communication, feedback, and awareness surveys

Lever #2: Boundary Systems

What formally stated rules, limits, and proscriptions tied to defined sanctions and credible threat of punishment

Why to allow individual creativity within defined limits of freedom

How
- codes of business conduct
- strategic planning sessions
- asset acquisition systems
- operational guidelines

When
- Business Conduct Boundaries: when reputation costs are high
- Strategic Boundaries: when excessive search and experimentation risk dissipating the resources of the firm

Who
- senior managers formulate with the technical assistance of staff experts (e.g. lawyers) and personally mete out punishment
- staff groups monitor compliance

Lever #3: Diagnostic Control Systems

What	feedback system that monitor organizational outcomes and correct deviations from the preset standards of performance
Why	to allow effective resource allocations to define goals to provide motivation to establish guidelines for corrective action to allow *ex post* evaluation
How	set standards measure outputs link incentives to goal achievement
When	performance standards can be preset outputs can be measured feedback information can be used to influence or correct deviations from the standard process or output is a critical performance variable
Who	senior managers set or negotiate goals, receive and review exception reports, follow-up significant exceptions staff groups maintain systems, gather data, and prepare exception reports

Lever #4 Interactive Control Systems

What	control systems that managers use to involve themselves regularly and personally in the decision activities of subordinates
Why	to focus organizational attention on strategic uncertainties and provoke the emergence of new initiatives
How	ensure that data generated by the system becomes an important and recurring agenda in discussions with subordinates ensure that the system is the focus of regular attention by managers throughout the organization participate in face-to-face meetings with subordinates continually challenge and debate date, assumptions, and action plans
When	strategic uncertainties require search for disruptive change and opportunities
Who	senior managers activey use the system and assign subjective, effort-based rewards staff groups act a facilitators

Internal Control Systems

What systems that safeguard assets from theft or accidental loss and ensure reliable accounting records and financial information systems

Why to prevent inefficiency in transaction processing, flawed decisions based on inaccurate data, fraud

How

Structural safeguards
- active audit committee
- independent internal audit function
- segregation of duties
- defined levels of authorization
- restricted access to valuable assets

Staff safeguards
- adequate expertise and training for all accounting, control, and internal audit staff
- sufficient resources
- rotation in key jobs

Systems safeguards
- complete and accurate documentation
- adequate documentation and audit trail
- relevent and timely management reporting
- restricted access to information systems and data bases

When at all times in all businesses

Who staff professionals (trained accountants, independent auditors)
managers usually should not spend much time designing or reviewing the details of internal controls

APPENDIX B—AIM-9X PROGRAM EXIT CRITERIA

Exit Criteria to Enter Low-Rate Initial Production

- Demonstrate Key Performance Parameters and APB threshold reliability and maintainability requirements are achievable through a combination of development test and analysis, including
    - Rated as potentially operationally effective and potentially operationally suitable in the Operational Assessment, based on at least 200 hours of captive carry and five guided missile firings in OT-IIA
- Analyze cost experience and price projections to confirm the ability to produce AIM-9X missiles at the price established in the LRIP option.
- Demonstrate critical manufacturing processes using manufacturing capability, factory transition, and design stability metrics.

Exit Criteria to Enter Full-Rate Initial Production

- Demonstrate Key Performance Parameters are met through a combination of operational test and analysis.
- Demonstrate critical manufacturing processes using manufacturing capability, factory transition, and design stability metrics.
- Demonstrate APB threshold reliability and maintainability requirements are achievable are met through a combination of operational test and analysis.

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